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# Science Education

## SCIENCE SEQUENCE AND ENROLLMENTS IN THE SECONDARY SCHOOLS OF THE UNITED STATES \*

GEORGE W. HUNTER AND LEROY SPORE  
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In the year 1909 the senior author made a study of biology teaching as it then existed in the United States. Questionnaires were sent out to 500 high schools, selected from United States Bureau of Education sources, as being representative of the better and larger schools in the United States. Replies were received from 276 schools and the findings were published.<sup>1</sup> This report showed that physiography and the biological science tended to appear early in the four-year curriculum of the senior high school. Botany and zoology at that time had a definite place in the tenth grade, with physiography as the predominating science in the ninth grade of the senior high school. Physics had the majority of holdings in the eleventh grade, and chemistry in the twelfth grade, although considerable divergence of opinion as to their place occurred. Note was made of the interesting introduction of elementary science (General Science) into the first year of the high school, and the equally interesting growth of a new subject called biology, particularly in New York state, at the ninth-year level. It was also noted that a few courses in biology appeared at the tenth-grade level. Human physiology and a few scattered "book courses" also were found at this time.

\* The findings on which this article is based were made possible by a grant from the Joint Research Committee of Claremont Colleges, Claremont, California.

<sup>1</sup> Hunter, George W. "The Methods, Content and Purpose of the Biological Science in the United States." *School Science and Mathematics* 10:1-10, 103-111; January, February, 1910.

In the autumn of 1923, a second questionnaire was sent out to those schools on the first list, and to about 500 additional high schools. This questionnaire was somewhat broader in scope than the first and was answered fully by 368 representative schools, including returns from 44 states and the District of Columbia. In general the second study<sup>2</sup> showed a slow but steady increase in the science offerings of the schools responding. According to statements of schools responding, 274 of 355 schools showed that more students were taking biology, chemistry, and physics than at the period 15 years previous, when the first questionnaire was answered. But in spite of this fact, evidence showed, while enrollments in general science and biology were rapidly increasing, the specialized sciences, botany and zoology in particular, and to a lesser extent chemistry and physics, were losing in enrollment. The study indicated a definite science sequence had become established, with general science widely predominating in the ninth year, with biology moving from the ninth to the tenth year, with chemistry and physics holdings about equally distributed between the eleventh and twelfth years of the secondary school. One noticeable difference between conditions in 1908 and 1923 was that, because of the establishment of general science and biology as "generalized courses," the offerings in physiography, botany, zoology and human physiography had greatly decreased in the

<sup>2</sup> Hunter, George W. "The Place of Science in the Secondary School." *School Review* 33:370-381, 453-466; May, June, 1925.

schools answering the 1923 questionnaire. One hopeful indication appeared, namely science in the high school was beginning to lose one of its "water-tight compartmentalizations" and correlation of a sort was beginning to appear. A large proportion of teachers answering the question "Are your science courses more clearly related to the science courses in the secondary school than they were 15 years ago?" answered in the affirmative, although 50 out of 301 were unable to answer this question, and 40 answered "No." There were indications from the answers given, that science was beginning to be more socialized, more humanized, and less limited in scope than in the earlier study. It was beginning to interpret the environment to the pupil, and, in some cases, was really teaching how to live.

A new factor in the science situation, namely, the junior high school, was giving evidence of a change in the distribution of science enrollment and distribution of science courses. It was evident to all secondary-school science teachers, that general science was rapidly expanding into the levels of the new junior high schools, but we had no factual evidence to rely upon. So a new and much more comprehensive questionnaire was formulated, and sent out in 1930 to the original 1,000 schools, and to 500 of the leading junior high schools in all parts of the country. This rather formidable questionnaire asked questions with reference to the objective of science at the different age levels, placement of courses with different offerings in terms of weeks, offerings per week, and laboratory courses, the sequence of science in the school or school system, the enrollment as of date compared with that of 20 years previous, and other questions relating directly to the methods of teaching, et cetera. Replies to this questionnaire were received from 528 schools, 209 being junior high schools, 119 three-year senior high schools, and 203 four-year senior high schools. In addition, replies were received from a

majority of the members of the National Association for Research in Science Teaching, some of whom were teachers in the schools replying, while others represented teacher-training institutions.

The findings of this questionnaire resulted in several published articles, of which two<sup>3, 4</sup> only have to do with the present paper. Several rather definite tendencies had now appeared, the most important being the very great increase both in numbers of courses and in enrollment in general science. This was caused by a spread downward movement into the junior high school. Although general science appeared in the seventh and eighth grades, the total offerings of the two grades were little more than equal to those in the ninth grade, according to the figures given by the returned questionnaires. Biology still retained its place in the tenth year, although there were a number of courses appearing at the ninth-grade level. In addition, there was a spread of biological science in the senior high school, due to the offerings of advanced biology. Physics and chemistry still appeared in the eleventh and twelfth grades, but with a tendency to offer more physics courses in the twelfth year. Sentiment, however, was mixed as to the placement of physics and chemistry in the sequence, certain schools placing chemistry first in the preferred sequence, while others placed physics first. In many small schools physics appeared in alternate years. Physics still appeared to be the preferred college entrance science, although chemistry was a close second, with biology far in the rear. Enrollments in the special sciences were relatively small, physiography, botany, human physiology and zoology, astronomy and geology apparently ranking in the order named.

<sup>3</sup> Hunter, George W. "The Sequence of Science in the Junior-Senior High School." *Science Education* 16:103-115; December, 1931.

<sup>4</sup> Hunter, George W. "Science Sequence in the Junior and Senior High Schools." *School Science and Mathematics* 33:214-223; February, 1933.



Several new subjects appeared, among them bacteriology and psychology. But few schools gave such courses, and the enrollment was small.

In answer to a question asking for data on science enrollment, compared with 20 years previous to the 1930 questionnaire, the following figures are of interest: 95 per cent of the schools answering stated they had proportionately more students enrolled in general science than twenty years earlier, three per cent less, and two per cent about the same; 86.1 per cent of the schools had more students enrolled in biology, 8.2 per cent less, and 5.7 per cent about the same; 71.9 per cent of the schools answering had more students enrolled in chemistry, 18.1 per cent had fewer and 19.5 per cent about the same. In physics 52.3 per cent had proportionately more students taking physics, 30.5 per cent had fewer, while 17.2 per cent had about the same. These figures are interesting in comparison with those obtained from the National Association for Research and Science Teaching. Of this group 11 said that there was a greater enrollment in elementary science; 10 a greater enrollment in biology, one a smaller enrollment; five said chemistry had a greater enrollment, five less, and one about the same; four said physics had a greater enrollment, five less, and one about the same. These figures were significant to teachers of science because they came from sources which would be favorable rather than unfavorable to teachers of science, and yet all indications showed that the specialized sciences of the upper high school level were losing ground in spite of a much larger enrollment in elementary science.

Hoping to receive some hint as to the possible reason for this, the following question was asked: "Do chemistry and physics gain anything from the earlier science courses?" The summary from the National Association for Research and Science teaching group, and the teachers who answered the questionnaire, indicated

that a very considerable group believed that there were gains. Two hundred and nine stated that these sciences gained considerably; 116 that there was little gain and 18 that there was no gain. One other question is interesting in this respect: "Are the science courses more closely related to other courses in the secondary school than they were 20 years ago?" Two hundred ninety-nine said that there was greater correlation, 31 no correlation and 14 said very little correlation, or qualified their answers.

The past decade has witnessed the greatest difference in science teaching from any previous corresponding period since the publication of the first questionnaire. The rapid rise of the so-called "progressive" point of view in science education, the newer emphasis on method rather than science as subject matter, and the increasing emphasis placed on evaluation procedures, all made it seem wise again to attempt to obtain responses from the original schools plus additional junior high schools and a sampling of the so-called "progressive schools." Accordingly a new list of schools was prepared, which included not only the schools answering the 1930 questionnaire, but also some 250 additional junior high schools; a scattering of "progressive schools"; and the secondary schools included in the Cooperative Study of Secondary School Standards,<sup>5</sup> making a total of about 2,200 schools. The list of high schools used was obtained from the Office of Education publication giving accredited high schools.<sup>6</sup> From this list, which contained the original 1,000 high schools, an additional number was selected based on population, so that each state had a proportionate number of representative high schools, based on the total number of schools and the school population. In

<sup>5</sup> *Evaluation of Secondary Schools*, Cooperative Study of Secondary School Standards, Washington, D. C., 1939.

<sup>6</sup> Carr, M. J. S. *Accredited Secondary Schools in the United States*. United States Department of Interior, Office of Education, Bulletin 1939, Number 2.

making out the junior high school list that of 1930 was used, plus an additional number of schools given by the American Book Company as representative junior high schools in the various areas. Since no governmental agency published this list, this seemed to be the best way of making up the quota.

The scope of the questionnaire was also enlarged to include not only a list of science objectives at the various age levels, but also questions on methodology and on

The senior author has had long experience with governmental statistics, and is inclined to believe that, although they are reliable within bounds, they are not always accurate, and it is not always possible to interpret them correctly. In *Statistics of State School Systems*,<sup>8</sup> which is the second chapter of the complete *Biennial Survey of Education*, the daily high school enrollment for 1938 is given as 6,226,934 (page 15). In *Statistics of Public High Schools*<sup>9</sup> which is Chapter V of the same survey,

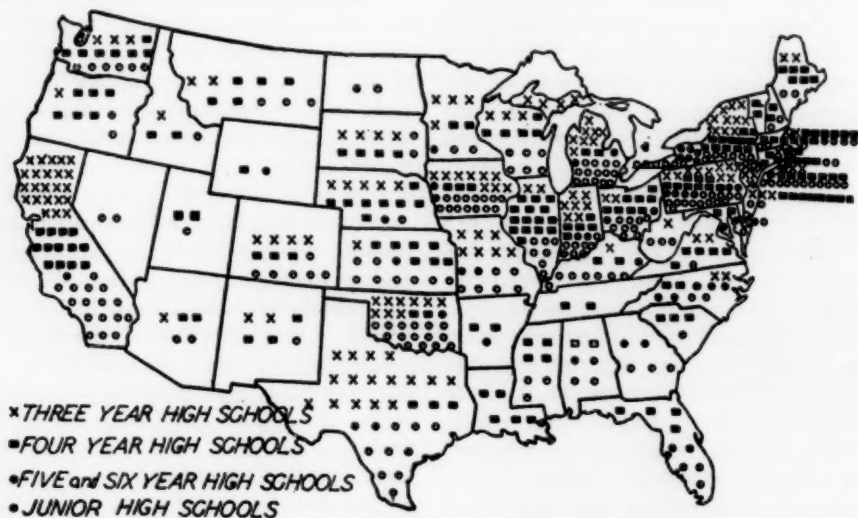


Figure 1.—Distribution of Schools Answering Questionnaires.

evaluation procedures. It was a rather formidable document which took at least two hours of honest work to answer, and the writer wishes at this time to thank the teachers who gave so generously of their time and interest in answering the questionnaire. Responses were received from some 655 schools, with a representation from every state in the Union. Figure 1 and Table I show the distribution of the schools. In the table the schools have been broken down into the groupings given in the *Biennial Survey of Education*.<sup>7</sup>

<sup>7</sup> *Statistics of Public High Schools—1937–38*, U. S. Office of Education, Bulletin 1940, Number 2, Chapter 5.

the total number of schools is given as 7,420,702 (page 3). According to a paper by Glass,<sup>10</sup> the total enrollment given by the United States Biennial Survey is 6,673,777. While these discrepancies may be in part accounted for by the various methods of obtaining the summaries and the numerous workers involved, it makes

<sup>8</sup> *Statistics of State School Systems, 1938*, U. S. Office of Education, Bulletin 1940, Number 2, Chapter II.

<sup>9</sup> *Statistics of Public High Schools, 1937–38*, U. S. Office of Education, Bulletin 1940, Number 2, Chapter V.

<sup>10</sup> Glass, H. B. "Enrollments, Teaching Loads and College Relations of Secondary School Biology: Data from a Questionnaire." *The American Biology Teacher* 4:27–36; October, 1941.

TABLE I  
NUMBERS AND SOURCES OF QUESTIONNAIRES RECEIVED

States	Types of High School				Total	Junior High School		Total
	3 yr.	4 yr.	5 yr.	6 yr.		2 yr.	3 and 4 yr.	
Connecticut	1	7			8	1	3	12
Maine	2	6			8	1	1	10
Massachusetts	2	12		1	15		5	20
New Hampshire		2			2		2	4
Rhode Island		2			2			2
Vermont		2			2			2
<i>New England States</i>	5	31		1	37	2	11	50
Delaware	1			1	2		1	3
Dist. of Columbia				1	1		1	2
Maryland		2		1	3			3
New Jersey	6	9			15		2	17
New York	13	21	1	5	40		27	67
Pennsylvania	10	9	1	5	25	1	13	39
<i>Middle States</i>	30	41	2	13	86	1	44	131
Alabama		2		1	3		3	6
Arkansas		2	1		3			3
Florida		4	1	2	7		3	10
Georgia			2		2	3		5
Kentucky	1	2	1		4		7	11
Louisiana		5			5			5
Mississippi		3		1	4	1	2	7
Oklahoma	9	1	1	1	12		21	33
North Carolina	2	2	5		9		2	11
South Carolina		3			3		1	4
Tennessee		2			2			2
Texas	15	3	1	1	20	1	8	29
Virginia	2	5	1		8			8
W. Virginia	1				1		3	4
<i>Southern States</i>	30	34	13	6	83	5	50	138
Illinois	2	16			18	7		25
Indiana	7	5	1	1	14	10		24
Iowa	9	3		2	14		14	28
Michigan	12	2	2		16		16	32
Minnesota	4	2	1		7		2	9
Missouri	7	4		2	13	2	4	19
Ohio	2	8		2	12		9	21
Wisconsin	3	5		1	9		5	14
<i>North Central States</i>	46	45	4	8	103	2	67	175
Arizona	1	2			3		2	5
Colorado	4	3			7		7	14
Idaho	1	2			3		1	4
Kansas	1	7		1	9		8	17
Montana	2	5			7	1	2	10
Nebraska	5	8		1	14		1	15
Nevada							2	2
New Mexico	2	3			5		1	6
N. Dakota			1		1		1	2
S. Dakota	4	3			7		2	9
Utah		2			2		1	3
Wyoming		1	1		2			2
<i>Rocky Mt. States</i>	20	36	2	2	60	1	27	88

TABLE I—(Cont.)  
NUMBERS AND SOURCES OF QUESTIONNAIRES RECEIVED

California	23	13	1	37	15	52
Oregon	1	5		6	2	8
Washington	3	7		10	6	16
<i>Pacific States</i>	27	25	—	53	23	76
United States	158	212	21	422	11	655

statistical comparisons difficult. One definite error noted was caused by the counting of enrollments from evening high schools as day schools; doubtless there are other equally glaring errors.

In our consideration of distribution of science students and courses, several points have to be considered. As is pointed out in the bulletins just quoted, reorganization of the secondary school is still far from complete, although there is a distinct trend in the direction of the 6-3-3 organization or its counterpart, the six-year undivided high school. This is clearly shown in our table of distribution of schools, but we must also take into consideration the fact that in many of the southern states there are eleven-year school systems instead of those of twelve years, and in such systems the junior high school begins with the sixth grade instead of the seventh. Moreover there are still a number of schools operating under the old transitional 6-2-4 plan, and still more small high schools using the 6-6 plan. In addition, a few school systems with junior colleges are operating under the 6-4-4 plan, with the junior high school embracing the seventh to tenth years, inclusive. But by far the most secondary schools still operate as four-year high schools. This is indicated clearly in the Biennial Survey which shows over three-fifths of all schools in this category. Our own table shows the same situation. The Biennial Survey gives no less than 29 different types of school organizations.

Bearing in mind these difficulties in obtaining accurate statistics, the authors have made an attempt to get a picture of secondary school enrollment, in order to make certain comparisons with the findings of

the questionnaire. For this purpose we have used tables giving enrollment in the various types of reorganized high schools found in the Biennial Survey, Chapter V.<sup>11</sup> The results of the summary of these tables is shown below.

REORGANIZED HIGH SCHOOLS—  
JUNIOR HIGH SCHOOL ENROLLMENT

Grade 6	Grade 7	Grade 8	Grade 9	Grade 10
24,587	719,803	781,469	617,443	15,218

These figures are of interest in comparison with certain other figures of enrollment, which will be given later.

The senior author has attempted to obtain figures on science enrollments by going directly to officials connected with the various state boards of education. This was done in order to attempt some sort of a comparison with the figures obtained from the questionnaire. It was soon found, however, that obtaining statistics on enrollment for the entire United States would be a well-nigh hopeless task. Some states, such as Rhode Island, Connecticut or Nevada, have no state statistics whatever and there was no way of obtaining them except by going to the individual schools. Other states, such as New York and California had the statistics, but were without clerical help necessary to tabulate the material. Other states, such as Pennsylvania,<sup>12</sup> Maryland,<sup>13</sup> Michigan<sup>14</sup> have printed sta-

<sup>11</sup> *Op. cit.*, pages 48-65.

<sup>12</sup> *Statistical Report of the Superintendent of Public Instruction*. Bulletin 73, Department of Public Instruction, Commonwealth of Pennsylvania, Harrisburg, 1940.

<sup>13</sup> *Annual Report of the Superintendent of Instruction*. Baltimore, Maryland, 1940.

<sup>14</sup> University of Michigan. *Annual Reports of the Bureau of Cooperation with Educational Institutions*, 1940.

tistical reports. Others, such as Massachusetts, and Utah, have mimeographed sheet reports. The summaries of these reports are given in this paper.

In the South, in particular, general science, or health science, has become a required, or at least an urged subject in the sixth, seventh or ninth years, depending on whether the state is on the 7-4 or 8-4 plan. Let us take some of the reports that have come in from the southern states. In Alabama, for example, general science is required in the seventh and eighth grades, while health science is required in the ninth grade. Thus, theoretically, at least, we have a science enrollment equal to the entire school population at those age levels. In Arkansas, general science is required in the seventh and eighth grades. In Florida and Georgia, although no specific requirements are made for the seventh and eighth grades, the enrollments given are apparently as high as the school enrollment. Georgia requires one year of science for graduation from high school. Kentucky enrollments in science for grades seven, eight, and nine, comprise three-fourths of the enrollment of the entire state. Louisiana, with the 7-4 organization, requires general science in the eighth grade, and has about the same science enrollment given for the seventh grade. Biology, chemistry and physics occupy, respectively, grades nine to eleven, with one science required for graduation. Mississippi requires general science and biology in the ninth and tenth grades. In North Carolina, with the 7-4 organization, science is given in grade seven, and general science is required in grade eight. Biology is "virtually required" in grade nine. Oklahoma gives junior science in grades seven and eight, and again "practically requires" general science in grade nine. South Carolina, with a 7-4 organization, requires general science in the seventh and eighth grades, and "strongly recommends" biology in the ninth grade. Tennessee gives science in the seventh and eighth grade levels,

and general science at the ninth grade level. Texas, with a 7-4 organization, states: "General Science may not follow any other science, and has been designated an eighth-grade subject, and should be so planned. Biology is a ninth-grade subject, and should not be regularly offered to students enrolled in their senior year. Physics and chemistry should not be taught below the tenth grade, and may not be offered to a student who has not had a full year of elementary science." The enrollment in grades seven, eight, and nine are apparently nearly those of the total school enrollment in this state. Virginia gives general science as an elective in grade nine, and requires biology in grade ten. West Virginia has "science" in the seventh and eighth years, and general science in the ninth year.

It appears, from figures received from state departments of education, that practically the entire enrollment of the seventh, eighth, and ninth years (and six of the eleven years), is exposed to some sort of science courses. Whether these are simply book courses is a question. In the case of "health science," we suspect that this is the case, and in the lower grades of the junior high school, where science is offered only two or three periods a week, it is largely observation and reading, but there is usually one year of real science required in the junior high school.

In other parts of the United States where figures were available the picture is similar to the south, in that general science or elementary science or "health science" appear to be either elective or required in all grades of the junior high school.

In the New England states the following data were obtainable. The Director of Secondary Education for the State of Maine writes in part as follows:

"In Grade VII about three thousand pupils have a regular course in general science of about two periods per week, or the equivalent, and in Grade VIII about four thousand five hundred have general science three times a week. In Grade IX general science is offered as an elec-



tive subject in all the secondary schools of Maine. About eight thousand students elect this subject. Biology is also an elective in every secondary school, with only one or two exceptions. About six thousand students elect this subject. About four thousand five hundred students are enrolled in chemistry, nine percent of them or more in courses that are college preparatory in nature despite the terminology of their basic textbooks and intentions of their instructors. About two thousand five hundred students are enrolled in physics, of which ninety percent is of the college preparatory type. Incidentally, there has been a pointed effort to bring about more practical chemistry and physics, and already there are some very good developments under way."

From New Hampshire the following information was gleaned. Elementary science is taught three times a week in Grade VII and three times a week to all pupils in Grade VIII. There were last year about five thousand nine hundred twenty-seven pupils in the two grades. Two thousand and four pupils studied general science in Grade IX. In 1940-41, 1,519 pupils were enrolled in physics and 2,716 in chemistry. There is, however, more attention being given to general physics and chemistry than ever before.

From Vermont comes the following reply from the supervisor of high schools:

"I am listing below the tabulation of the enrollment in the subjects you listed in both the public high schools and private academies.

	Public	Private	Total
General Science			
Grade 7 and 8	951	14	965
Grade 9	2,459	572	3,031
Biology	2,656	561	3,217
Physics			
College Preparatory } Practical or General }	835	201	1,036
Chemistry			
College Preparatory } Practical or General }	1,440	382	1,822

"I regret that it is not possible for us to give you from our records the number in each the College Preparatory and Practical or General courses in Physics and Chemistry, as we have not divided these two groups in our report forms; however, I am planning to make a division for the coming school year."

From Rhode Island Mr. James F. Rockett, director of education, writes:

"According to Rhode Island law everything pertaining to subject matter courses is left entirely in the hands of local authorities. For this reason we require and receive only total numbers pertaining to attendance of all grade levels."

It was also impossible to obtain figures from Connecticut.

The State of Massachusetts gave the following figures for high school subjects studied for 1940-41.

Subject	Number of high schools offering subject	Number of pupils taking subject
General Science .....	163	16,068
Biology .....	238	27,797
Chemistry—Col. Prep.....	192	11,377
Combined Col. Prep. and general chemistry .....	12	526
General chemistry .....	124	10,404
Physics—Col. Prep. ....	180	6,478
Combined Col. Prep. and general physics .....	110	201
General physics .....	114	8,284
Botany .....	9	554
Zoology .....	2	189
Physiology and hygiene.....	109	7,481

These figures are interesting particularly because of the indication that even a conservative state like Massachusetts is giving courses in chemistry and physics which are intended to reach the student not directly preparing for college.

In the area designated in this and previous papers as the Middle States some incomplete statistics are available. In New York state, as is well known, not all science students take the so-called "Regents" examination." However, statistical information is given only for this group. Complete figures in science enrollment for the junior and senior high schools was discontinued in 1934. The latest documentary evidence obtainable is the report on the Regents' examination for January and June 1940. This report gives no figures for general science, but shows 47,087 biology papers written, 37,739 chemistry papers, 29,992 physics papers, and 8,720 papers in physical geography. Some sci-

ence figures on science registration for New York City for the spring term of 1940 were also obtained. Junior high school pupils all take general science. In the seventh and eighth grade of the elementary schools there were 83,271 pupils taking science. In the junior high schools (7A-9B) there were 127,587 pupils taking science. In the senior high schools there were 21,955 pupils in the first term of general science, and 24,085 in the second term of general science. Also in the ninth grade in 1940 there were 872 pupils in the first term of elementary biology and 2,605 in the second term of elementary biology. Other figures for the general high schools were:

General Biology: 1st term...	4,659
2nd term...	3,284
Advanced Biology: 1st term	16,214
2nd term	14,688
Physics: 1st term.....	5,630
2nd term.....	5,061
Chemistry: 1st term.....	9,195
2nd term.....	7,657
Physiography: 1st term.....	3,551
2nd term.....	2,998

New Jersey in 1939-40 had an enrollment of 221,373 in grades nine to twelve inclusive, and of this number 47,980 or 21.7 per cent, were enrolled in general science; 33,405 or 15.1 per cent in biology; 15,526 or 7 per cent in chemistry; and 13,743 or 6.2 per cent in physics. In ap-

proved junior high schools 4,946 out of a total of 15,233 were taking general science in the seventh grade, and 8,786 out of 15,889 were taking general science in the eighth grade. There are, however, a large number of pupils enrolled in the seventh and eighth grades of schools which although they call themselves junior high schools are not approved by the State Board of Education and hence are not included in these statistics. The Commissioner of Education gives the total enrollment in grades seven and eight of 123,444, and he *assumes* the science enrollment to be the same. To what extent this assumption is true is only a guess.

The state of Pennsylvania in its statistical report of 1938-39<sup>15</sup> gives the data shown in the table below.

The state of Maryland gives the enrollment in science in the annual report of the Superintendent of Public Instruction<sup>16</sup> but fail to segregate their science figures into subjects. Fourteen thousand three hundred ninety boys and 14,735 girls, or a total of 29,125, take science in the secondary school. The Assistant Superintendent of Public Instruction makes the following

<sup>15</sup> *Statistical Report of the Superintendent of Public Instruction*. Bulletin 73, Commonwealth of Pennsylvania, 1940.

<sup>16</sup> *Annual Report*. State of Maryland, Department of Education, 1940.

Pennsylvania Data by Grades

Subject	Total	VII	VIII	IX	X	XI	XIII	PG
Advanced science ..	* 8,996	..	..	1,014	1,620	2,242	3,699	..
Aeronautics .....	12	..	..	..	..	..	12	..
Applied science ....	2,221	..	..	231	829	674	487	..
Astronomy .....	80	..	..	..	..	..	80	..
Biology .....	100,181	..	..	2,470	91,166	4,498	2,031	16
Botany .....	1,550	499	9	..	78	810	154	..
Chemistry .....	* 46,659	..	..	973	628	22,810	21,005	198
General science ....	* 182,847	10,013	32,676	135,278	3,391	530	626	..
Geography .....	98,900	49,180	45,511	896	994	1,174	807	13
Geology .....	82	..	..	..	..	..	82	..
Physical geography ..	* 994	141	172	135	124	89	264	1
Physics .....	* 34,226	..	..	..	2,414	18,422	12,652	20
Zoology .....	968	..	..	..	506	254	198	..

\* Distribution by grades not reported by certain districts.

statement on science in Baltimore:

"All eighth grade pupils have General Science as a major subject in both 8B and 8A. In the ninth grade it is given to the academic pupils and to the general group taking science as a major for one whole year. The Commercial pupils get it in the 9B grade only. The general group taking a modern language and not preparing to enter the Baltimore Polytechnic Institute does not get it. In the senior high schools we give biology in the 10th grade, physics in the 11th, and chemistry in the 12th grade. According to the figures of our Bureau of Research the enrollment in biology, physics and chemistry last semester was as follows:

	White schools	Colored schools
Biology .....	3,643	534
Physics .....	2,243	446
Chemistry ..	1,994	346

Very truly yours,  
J. CAREY TAYLOR,  
Assistant Superintendent."

No statistics were obtained for Delaware and the District of Columbia.

The North Central States have not given as full statistical information as some other parts of the country. No information has as yet been received from Illinois. Indiana schedules and requires science in grades I to VIII inclusive. "General Science in the ordinary sense of the word is not permitted above the eighth grade." Apparently biology has large holdings in both ninth and tenth grades as do physics and chemistry

in the eleventh and twelfth grades. Indiana requires one year of science in high school.

The Superintendent of Public Instruction in the State of Iowa reports:

ENROLLMENT IN SCIENCE COURSES IN  
IOWA HIGH SCHOOLS, FIRST  
SEMESTER, 1940-41

	Grades	Total schools	Total enrollment
General science...	9	723	20,126
Biology .....	10	521	15,078
Physics .....	11	508	8,994
Chemistry .....	12	89	2,510
Practical science..	12	16	227
Senior science....	11-12	48	1,047

According to the statement of the Superintendent of Public Instruction these figures are not absolutely accurate "since they were taken from the reports of the high school daily program sent to this office by every school in the state . . . in a few cases the class enrollments were not given and a few of the schools did not send in reports. We believe, however, that these are dependable approximate figures."

Michigan gives partial statistics through the University of Michigan publication<sup>17</sup> previously mentioned which gives registra-

<sup>17</sup> *Annual Report of the Bureau of Co-operation with Educational Institutions.* University of Michigan Official Publication: Vol. 42, No. 58, Jan. 18, 1941.

MICHIGAN ENROLLMENTS IN SCIENCE

Subjects *	Public		Nonpublic		Total				
	Schools	Pupils	Schools	Pupils	Schools	Pupils			
General science.....	165	(10)	22,505	66	(5)	4,471	231	(15)	26,976
Physical geography ..	24	(6)	1,819	1		2	25	(6)	1,821
Descriptive biology ..	15		2,651				15		2,651
Biology .....	494	(9)	42,217	85	(5)	4,120	579	(14)	46,337
Botany .....	5	(1)	479	1		79	6	(1)	558
Zoology .....	3	(1)	460		(1)		3	(2)	460
Descriptive physics...	43	(5)	2,691	2		70	45	(5)	2,761
Descriptive chemistry	27	(19)	1,530	3		56	30	(19)	1,586
Physics .....	358	(94)	12,677	45	(18)	1,237	403	(112)	13,914
Chemistry .....	400	(73)	24,699	81	(5)	2,696	481	(78)	27,395
Physiology .....	35	(6)	2,258	2	(1)	15	37	(7)	2,273
Geology .....	2	(1)	85				2	(1)	85
Others .....	25	(1)	1,677				25	(1)	1,677
Total.....			115,748			12,746			128,494

\* Numbers in parenthesis indicate subjects offered, no registration reported.

tion in science in 622 accredited Michigan high schools, both public and non-public. These figures, although they represent only a part of the state offerings, are interesting because they give enrollment in the better schools.

A second table shows enrollment in public high schools which enroll less than 200 pupils. Fifty-five schools give general science to 1,598 students; 262 schools give biology to 8,756; 155 schools give physics to 3,062 students; 184 schools give chemistry to 4,938 students. These, with other scattering offerings in science, total 18,986 pupils registered in science. It was impossible to secure any data on science in the 7th and 8th grade for the state. In Detroit, however, Mr. C. L. Thiele, Director of Exact Science in the Detroit Public Schools, estimates the total general science enrollment in the 7th, 8th and 9th grades at about 30,000 pupils for that city. An estimated number of 24,747 took science in the high school. The percentage of students in science classes in the various schools running from 39.20 per cent in the Chadsey and Northeastern high schools to 60.60 per cent in the Cooley high school.

The figures obtainable from Minnesota were incomplete. Five hundred and thirteen high schools give a total of 29,836 students taking general science in ninth year and 25,558 students in 495 high schools take biology in the tenth year. Chemistry appears in 362 high schools with a total enrollment of 13,363 and physics appears in 324 high schools, with a total enrollment of 9,241. In Minneapolis and St. Paul general science is a required subject in grade seven and eight and has an enrollment of 7,275 in the seventh and 8,172 in the eighth grades for these two cities. The enrollment for the remainder of the state was unobtainable.

In the state of Missouri figures were obtainable from the schools exclusive of St. Louis, Kansas City and the high schools maintained by the State Teachers Colleges and the University of Missouri. For

these schools the following statistics are available:

	No. H.S. All classes	Grade placement	Total enrollment
General science	687	9 or 10	27,561
Biology .....	444	10 or 9	15,850
Physics .....	160	11 or 12	3,458
Chemistry ....	111	12 or 11	3,771
Total....			50,640

When the total enrollments for the two cities are added to the state figures we have a total of 33,333 for general science, 23,230 for biology, 6,027 for chemistry and 5,396 for physics. These figures represent approximately the state enrollment.

Ohio reports the following conditions taken from *Ohio High School Standards*.

"General science is required of all pupils in the Junior High School and is probably the best science to require of all in the high school which is not organized with a junior high program. If general science is not required of all students in the latter case, biology should be required of those who do not take general science."

"In schools that cannot be equipped to offer both physics and chemistry, the preference of the Department is physics. In most small schools the alternation of physics and chemistry is possible. This will enable the student to make the choice. No school should require either of these sciences in all courses."

"A second year of any one science is not approved unless the work is definitely designed to meet certain felt needs."

The science enrollments for the state, although not usable because the special science offerings are not designated, indicate that there is a very large enrollment of science at the seventh, eighth and ninth grade levels, and that there is a relatively large enrollment in science at all grade levels.

Wisconsin unfortunately does not give the complete figures, the science data having been obtained from Milwaukee. These are as follows: general science, ninth grade, enrollment 4,892; biology, tenth grade, enrollment 4,514; chemistry, eleventh grade, enrollment 2,487; physics, twelfth grade, enrollment 1,672.

In the Rocky Mountain and Great Plain states, we have to date only data from four states, Nebraska, New Mexico, South Dakota and Utah. Kansas gives simply a high school enrollment of 111,953 from grades nine to twelve inclusive. It gives no figures for the junior high school or for the enrollment of science subjects. Nevada states that no information regarding science enrollment was available for the state.

Nebraska gives a total enrollment for the state of 11,370 in general science, 11,645 in biology, 5,269 in physics, and 3,605 in chemistry. General science is placed in the ninth grade, biology in the tenth, and physics and chemistry in the eleventh or twelfth. No information was obtainable on science in grades seven and eight.

New Mexico gives an enrollment of 10,766 in grade seven, 9,350 in grade eight, and 7,564 in the general science of grade nine. Biology is placed in grade ten (or eleven) and has an enrollment of 6,334. Physics is placed in grade eleven (or twelve) and has an enrollment of 5,015. Chemistry is placed in grade twelve (or eleven) and has an enrollment of 4,392.

South Dakota gives an estimated, fairly accurate enrollment as follows:

"General Science for Freshmen, 10,800; Biology for Sophomores, 7,500; Physics for Juniors, 4,000 and Chemistry for Seniors, 4,000."

"The total enrollment in high school (grades nine to twelve) is approximate 39,000, with dis-

tribution as follows: Freshmen, 12,000; Sophomores, 10,000; Juniors, 9,000 and Seniors, 8,000."

"The smaller schools of South Dakota practice the plan of alternation of subjects in order to offer a wider choice of subjects. . . . Hence Biology may be taught every other year and opened to Sophomores and Juniors. Physics and Chemistry are generally alternated and offered only to Juniors and Seniors."

The state of Utah issues a mimeographed leaflet which gives the following information for 1940-41: General Science is taught in grades seven, eight and nine, Biology in grade ten, Chemistry and Physics in grades eleven and twelve. There is a total enrollment in the seventh grade of 10,923, in the eighth grade of 11,284, in the ninth grade of 11,891, in the tenth grade of 11,413, in the eleventh grade, 10,363, in the twelfth grade 9,586, and 213 post graduate students, making a total in the junior high schools of 21,400 and in the senior high schools of 37,427. General science is offered in 42 schools and has an enrollment of 3,862. Biology is offered in 61 schools and has an enrollment of 4,069. Chemistry is offered in 51 schools and has an enrollment of 3,566. Physics is offered in 40 schools and has an enrollment of 1,824. In addition to this, there is a physiology enrollment of 2,539, a psychology enrollment of 2,539, a botany enrollment of 681 and a zoology enrollment of 700.

*(To be concluded)*



## A DETERMINATION OF THE RELATIVE IMPORTANCE OF PRINCIPLES OF PHYSICAL SCIENCE FOR GENERAL EDUCATION \*

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The tendency toward further integration of the traditional science subjects in curricula which are designed to meet the needs of general education has stimulated this attempt to determine the needs of the citizen in the realm of the physical sciences.

### PROBLEM

The purpose of this investigation is to determine what principles of physical science are most important for general education.

A number of terms which are repeatedly used are defined for the purpose of this study as follows:

1. A principle is defined in terms of four criteria:

- A. To be a principle a statement must be a comprehensive generalization describing some fundamental process, constant mode of behavior, or property relating to natural phenomena.
- B. It must be true without exception within limitations specifically stated.
- C. It must be capable of illustration.
- D. It must not be a definition.

These criteria represent a consolidation and modification of those employed by Robertson,<sup>1</sup> Pruitt,<sup>2</sup> and Arnold.<sup>3</sup> In

\* Abstracted from one section of a Dissertation for the degree of Doctor of Philosophy, University of Michigan, 1941.

<sup>1</sup> Robertson, Martin L. "The Selection of Science Principles Suitable as Goals of Instruction in Elementary Science." *Science Education* 19:1-4, 65-70, February and April, 1935, p. 1.

<sup>2</sup> Pruitt, Clarence Martin. *An Analysis, Evaluation, and Synthesis of Subject-Matter Concepts and Generalizations in Chemistry*, p. 158. (Distributed through *Science Education*.)

formulating these criteria the investigator was assisted by two competent persons, both of whom have had long experience in the field of science education,\* and by members of a graduate seminar in science education at the University of Michigan, to whom the proposed criteria were submitted for criticism and suggestions.

2. The term "general education" designates those educational activities which are designed to meet the needs of all pupils enrolled in elementary and secondary schools (Grades I to XIV, inclusive), without regard to future vocational and professional interests.
3. A "problematic situation" is a question which suggests the explanation of an observable fact or series of closely related facts which are implied in the question as stated.
4. An "application" designates a "problematic situation" involving in its explanation or solution an understanding of one or more of the principles of physical science.
5. The term "average citizen" refers to a member of that group of American citizens which may be thought of as extending one probable error ( $\pm 1$  P.E.) above and below the hypothetical mean of American citizens.
6. The field of "physics" is conceived as including those phenomena frequently

<sup>3</sup> Arnold, Herbert J. *The Selection, Organization, and Evaluation of Localities Available for the Unspecialized Field Work in Earth Sciences in the New York City Region*. Bureau of Publication, Columbia University, New York, 1936, pp. 26 and 27.

\* Wesley C. Darling, School of Education, University of Michigan, and Francis G. Lankford, School of Education, University of Virginia.

- classified as belonging in the specialized areas of physics and astronomy.
7. The term "physical science" includes the fields of chemistry, geology, and physics (as previously defined).
  8. By the term "practical value" is meant value, for actual use in the daily life of the "average citizen" apart from vocational or professional interests.
  9. By the term "cultural value" is meant value, as knowledge, apart from practical value, and reduced to readily comprehended essential concepts by elimination of purely technical aspects. Such knowledge may be considered to derive its value from the fact that it (1) is satisfying in itself because it stimulates and satisfies intellectual curiosity, or (2) contributes to the development of aesthetic appreciations. Thus, a knowledge of the cause of an eclipse, or of the probable cause of the Aurora Borealis or of the fact that chemical elements may be made to undergo transmutation, would possess "cultural value."

#### METHOD

The principles of physical science which have been evaluated in this investigation have emerged as a result of the techniques employed. However, the necessity for nuclei about which to organize the material as it was collected made it desirable at the outset of the study to build up a tentative list of principles. This list was subsequently modified as the need for such modification became apparent during the progress of the study. The method employed in assembling this tentative list of principles follows:

Four studies published within the past five years, three of them doctoral dissertations, contain lists of principles or generalizations drawn from one or more of the fields of physical science. In three of these studies (those by Arnold, Pruitt and Robertson), the criteria employed for the

selection of principles or generalizations are very similar to those adopted for use in the present investigation. In the fourth study the investigators<sup>4</sup> utilized a somewhat different method of defining a principle.\* However, the resulting principles in this study are quite similar in nature and method of statement to those resulting from the other three studies. The lists of principles included in these four studies were utilized as sources in the development of a tentative list for use in the present investigation.

Each principle contained in each of the source lists was written on a four-by-six card. These cards were sorted and those bearing principles which were identical or which, in the opinion of the investigator, were nearly alike were clipped together. This procedure revealed the fact that certain of the source lists contained several principles which were nearly identical. The principles appearing on all cards were then transferred to a master list which retained the grouping of principles considered to be nearly alike. The principles included in this master list were considered one by one by a jury consisting of the investigator and two other persons, each of whom is a member of the science staff of a School of Education.†

Principles which stood alone in the master list were retained if, in the joint opinion of this jury, they met the investigator's criteria. If they failed to meet the criteria but seemed capable of being reworded in an acceptable manner, they were reworded and retained; otherwise they were discarded. The jury selected for retention

<sup>4</sup> Hartman, George W., and Stephens, Dean T. "The Optimal Teaching Sequence for Elementary Physical Principles Based on a Complete Scale of Pleasure-Value and Difficulty of Insight." *Journal of Educational Psychology*, XXVIII: 414-436, September, 1937.

\* In this study a principle is defined as "A functional relation or 'whole' involving the interconnection of two or more concepts."

† Francis G. Lankford, School of Education, University of Virginia, and Wesley C. Darling, School of Education, University of Michigan.

from each group of similar principles that one which was, in their judgment, so stated as to meet the criteria best. If such procedure proved impossible, some one principle of each group was either reworded in an acceptable manner or all principles of the group were discarded. In a few instances several principles of a group were retained if, in the joint opinions of the jury, such principles should not be considered to be duplicates. The resulting list contained 252 principles distributed as follows among the three fields: physics 165, chemistry 68, geology 19.

Following the selection of principles by jury, the entire list was submitted to a member of the physics department of the University of Michigan\* who carefully checked each of them against the investigator's criteria and made many suggestions for their restatement in accordance with the criterion, "It must be true without exception within limitations specifically stated." These suggestions were incorporated into the statement of the respective principles by the investigator.

In order to provide a further check on the manner of statement of the chemistry and geology principles, the principles in each of these respective areas were later submitted to a specialist in each field.† Each of these specialists made written recommendations for the restatement of certain principles in accordance with the criterion pertaining to accuracy of statement. In the final revision of the list by the investigator, such principles were reworded in accordance with the suggestions of these specialists.

As a result of the technique of refinement described, 191 of the 252 principles originally selected by jury as meeting the investigator's criteria were restated.

In this section of the investigation the

\* Ernest F. Barker, Head of the Department of Physics, University of Michigan.

† B. C. Hendricks, Department of Chemistry, University of Nebraska, and E. E. Lackey, Department of Geography, University of Nebraska.

method of evaluating principles as potential objectives of a program of general education depended on the assumption that the importance of an understanding of a principle may be measured by the extent to which the understanding functions in the explanation of problematic situations frequently encountered in everyday living. The need for such a determination of the relative values of principles is suggested by the words of Downing: "If the public schools, both elementary and secondary, could concentrate on the mastery of those principles of science that are most often needed in the solution of those problems that arise in the life of Mr. Everyman and on the clarification of the apperceptive mass needed to understand them, then the pupils would be prepared for life in the field of science."<sup>5</sup>

An evaluation of the principles of physical science on this basis, obviously involved as a starting point the establishment of a set of valid criteria for recognizing such problematic situations or applications. While it is possible that no perfectly defined boundaries can be established which will serve to identify these applications unmistakably, some guidance has been provided by categories which have been set up for defining content material on the basis of the needs of children, adolescents, or intelligent laymen.

The Committee on the Function of Science in General Education has utilized four categories for judging the worth of a learning activity to an adolescent.

In surveying the needs of the adolescent, the committee has found it helpful to think of the involvements of youth in terms of four basic aspects of living: (1) Personal Living; (2) Immediate Personal-Social Relationships; (3) Social-Civic Relationships; and (4) Economic Relationships. The study of adolescents indicates that

<sup>5</sup> Downing, Elliot R. *An Introduction to the Teaching of Science*. Chicago: The University of Chicago Press, 1936. p. 26.

these categories are psychologically valid and of undoubted significance for young people at the present time.<sup>6</sup>

Craig has made use of three criteria for selecting curricular material in elementary science which would help boys and girls to become intelligent laymen. These are:

- A. Certain objectives that are selected for elementary school science should conform to those scientific conceptions (1) which, when understood, greatly influence the thought reaction of the individual; and (2) which have modified thinking in many fields.
- B. Certain objectives that are selected for elementary school science should conform to those goals (information, skills, and habits) in science that are important because of their function in establishing health, economy, and safety in private and public life.
- C. Certain objectives that are selected for elementary school science should conform to those facts, principles, generalizations, and hypotheses of science which are essential to the interpretation of the natural phenomena which commonly challenge children.<sup>7</sup>

Craig further has pointed out that these criteria, especially the first two, "may be equally as important in the secondary schools and even in adult education, as in the elementary school."<sup>8</sup>

Pieper, in the *Thirty-first Yearbook*, has pointed out that the specific human behaviors to which a study of science at the junior-high-school level may contribute are of two kinds:

1. Those which satisfy mental curiosity concerning phenomena and applications in the field of science—that is, the intellectual adjustments to the environment.
2. Those which represent the "practical" tasks or activities met in everyday

<sup>6</sup> Progressive Education Association, Commission on Secondary School Curriculum. *Science in General Education*. New York: D. Appleton-Century Company, 1938. p. 27.

<sup>7</sup> Craig, Gerald S. *Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School*. Bureau of Publications, Teachers College, Columbia University, 1927. pp. 12-13.

<sup>8</sup> *Ibid.*, p. 13.

living—that is, the practical adjustments to the environment.<sup>9</sup>

Each of these expressions of point of view appear to make provision for curricular material which would have practical value to the child, the adolescent, or the educated layman, and, in addition, also to make provision for other material, apart from the practical, which might be thought of as satisfying the intellectual or cultural needs of an active citizen of American Democracy.

In order, therefore, that the criteria employed in this study for the selection of applications should conform to present opinion as to the purpose and function of general education, it seemed desirable that the criteria selected should place emphasis on both the practical and cultural aspects of science. Accordingly, the criteria were stated as follows:

An application shall be considered to be a suitable one if, in the opinion of the investigator, it

- A. Represents a problematic situation involving in its solution an understanding of one or more of the principles of physical science;
- B. Suggests information which in itself would be of practical value in daily life apart from vocational or professional interests, or which would possess cultural value to the average citizen apart from practical value.

On the other hand, an application shall be considered to be unsuitable if, in the opinion of the investigator, it suggests

- A. Information regarding detailed laboratory procedures involving the manipulation of apparatus not suitable for practical use outside the laboratory;
- B. Details of industrial or scientific processes or procedures usually of immediate concern only to specialists in some particular industry or field of science.

Having set up what were considered to be acceptable criteria for the selection of applications, the next step in the solution of the immediate problem concerned the selection of sources from which a reasonably comprehensive list of such applications

<sup>9</sup> National Society for Study of Education, *Thirty-first Yearbook*, Part I, Public School Publishing Company, Bloomington, Illinois, 1936, p. 197.

might be procured. While authors of textbooks are sometimes accused of adhering too rigidly to the needs and requirements of those preparing for specialized fields, there is little doubt that those who have written recent textbooks designed for use at secondary levels have not entirely neglected the needs of general education. It seems probable that the authors of such texts, in realization of the fact that functional understanding of scientific principles depends largely upon practice in applying those principles to life-like situations, have not neglected to provide opportunity for

It was assumed (1) that these books represent an adequate sampling of texts containing physical science materials which are intended for use at pre-specialization levels, and (2) that their analysis would reveal the classifications most likely to yield new applications and thus the ones from which additional sources should be selected for analysis.

In order to avoid unfavorable comparisons, each source has been designated by a number rather than by title or author. Table I presents data relative to texts utilized as sources.

TABLE I  
SOURCES OF APPLICATIONS

Book Number	Classification	Grade Level	No. Pages	Year of Publication
1	Physics	Senior H. S.	662	1939
2	Physics	Senior H. S.	632	1938
3	Chemistry	Senior H. S.	802	1939
4	Chemistry	Senior H. S.	777	1934
5	Survey—Physical Science	Senior H. S.	692	1939
6	Survey—Physical Science	Senior H. S.	835	1937
7	Survey—Physical Science	Junior College	812	1937
8	Survey—Physical Science	Junior College	514	1934
9	General Science	Junior H. S.	752	1940
10	General Science	Junior H. S.	753	1938
11*	Survey—Physical Science	Junior College	471	1938

\* Added later in accordance with the technique employed.

this application in their texts. This should be particularly true for those texts which purport to be so organized as to meet the needs of general education. In agreement with this line of reasoning, it was decided to utilize, as sources of application, textbooks intended for use at pre-specialization levels.

Two books from each of the following five classifications were selected as basic sources of applications:

1. Junior-high-school general science texts.
2. Senior-high-school survey texts (physical science).
3. High-school chemistry texts.
4. High-school physics texts.
5. Junior-college survey texts (physical science).

A preliminary examination of the sources indicated that the applications contained therein could usually be divided into two types, (1) those which were discussed and described in the body of the text and (2) those which were suggested by questions asked either in the body of the text or in connection with introductory or summarizing divisions or illustrations.

A page-by-page analysis was made of book No. 1 (see Table I). All applications were tabulated which in the opinion of the investigator, (1) came within the scope of the criteria, (2) were sufficiently described that the reader of average intelligence and of the maturity level for which the text was intended, should be able to understand



them, or (3) the explanation of which should be readily inferred as a result of reading the text material. Since it did not seem practicable to attempt to preserve the exact wording of the author or authors, the meaning of each application was carefully paraphrased in the words of the investigator.

Each application selected was placed on a three-by-five card, together with the name of the author and of the text, and the page from which the application was taken.

It was apparent that either of two methods could be employed in assigning applications to the principles involved in their explanation.

- A. Applications resulting from the analysis of all sources could be brought together, duplications eliminated from the entire list, and the remaining different applications individually assigned to principles.
- B. Applications resulting from each analysis could be individually assigned to principles, and duplications eliminated from the total assignments to each principle.

The latter of these methods, although involving much more effort seemed preferable for use in this study, for the following reasons:

- A. Preliminary trials disclosed the impossibility of invariable assignment of identical applications to principles. Since the measure of relative importance of principles was to be determined by the number of different applications assigned to each principle, it seemed wise to utilize a method which would take advantage of this variability and thus provide a somewhat wider range of defensible assignments for each application than would be achieved by a single assignment as provided by the first method.
- B. It was desired that the method of analysis and of assignment of applications resulting from the ten basic sources should indicate the classifica-

tion of sources which had possibilities of yielding the greatest number of new applications. This procedure necessitated keeping the applications resulting from the analysis of each text separate.

In accordance with this decision, each application resulting from the analysis of the first text was individually checked against the investigator's tentative list of principles. Whenever, in the opinion of the investigator, a principle was involved in the interpretation or explanation of an application, the number designating that principle was written on the card below the application. If a principle, considered to be essential to the explanation of an application, was not included in the tentative list, it was formulated by the investigator, and its statement and adherence to the criteria for a principle subsequently subjected to the same checking procedure as those of the original tentative list.

The next step in procedure involved placing each principle at the top of a separate page, ruled as shown in Form I and bound in loose-leaf notebook covers, so that pages could be added as needed. The application from each card was then transferred to these tabulation sheets by writing it in under those principles to which it had been assigned and checking it in the column under the number designating book No. 1.

Applications resulting from a similar analysis of the second book were assigned to principles in exactly the same manner, except that, if an application considered by the investigator to be identical with the one on a card, had already been entered under a principle, it was not written in again but was checked in the column under the number designating the second book analyzed. All other applications were written in and also checked in column two. This procedure was followed exactly as applications resulting from the analysis of subsequent books were entered on these tabulation sheets. The sample tabulation sheet which follows (Form I) shows the manner of

## FORM I

## METHOD OF ASSIGNING APPLICATIONS TO PRINCIPLES \*

Bodies in rotation tend to fly out in a straight line which is tangent to the arc of rotation.

	1	2	3	4	5	6	7	8	9	10	11
1. Why automobiles tend to skid on curves.	✓	✓					✓				✓
2. How a centrifugal clothes drier operates.	✓				✓	✓	✓				✓
3. How a centrifugal pump operates.....	✓				✓	✓			✓	✓	✓
4. How a cream separator separates milk from cream.....	✓	✓			✓		✓			✓	
5. Why turns on highways and railroad tracks are banked.....	✓				✓	✓			✓	✓	✓
6. Why the earth is slightly flattened at the poles.....	✓						✓				✓
7. Why mud or gravel flies off an automobile wheel in a straight line.....	✓	✓									
8. How an engine governor regulates engine speed.....	✓						✓		✓	✓	
9. Why the planets revolve about the sun..		✓						✓			
10. Why a stone may be thrown with greater force through use of a slingshot.....	✓										
11. How sugar is obtained and refined.....		✓	✓								
12. How the Babcock milk tester separates butter-fat from milk.....				✓							
13. Why the moon and sun retain their relative distances from the earth.....					✓						
14. Why the depth of the earth's atmosphere is greater at the equator than at the poles.						✓					
15. How scientists explain the formation of the solar system.....						✓					
16. Why a skater leans when turning a curve.											✓

\* This tabulation sheet is intended merely as an example of the method utilized in assigning applications to principles. An exactly similar form was used for each of the 246 principles to which applications were assigned.

assigning applications to one of the principles of physics.

Table II shows that when the applications resulting from the analysis of the ten sources had been assigned, the total number of applications assigned to all principles was 3,272. This number was subsequently increased to 3,403 by the addition of applications resulting from the analysis of an eleventh book selected in accordance with techniques which are described later.

The practice of assigning the applications resulting from the analysis of each text separately also afforded a means of predicting which classification of source should be most likely to yield additional applications not found in any of the ten basic sources. Column B, Table III indicates that Book

No. 7 was responsible for a slightly greater percentage of the total number of applications assigned to principles than any other one of the basic sources. This fact suggested that the analysis of another text selected from the classification to which Book No. 7 belonged (Survey—Physical Science—Junior College Level) might yield sufficient new material to justify its inclusion as a source. Book No. 11 was, therefore, analyzed and the resulting applications assigned to principles exactly in accordance with the procedure utilized in case of the other ten sources. The addition of applications from Book No. 11 resulted in raising the total number of applications assigned to all principles from 3,272 to 3,403. In other words, this source contributed 131

TABLE II  
ASSIGNMENTS OF APPLICATIONS FROM THE TEN BASIC SOURCES

	A	B	C	D
Book	Number of Applications Resulting from Analysis	Number of Assignments of Applications to Principles	Number Duplicate Assignments	Number New Assignments
1	440	657	0	657
2	408	774	257	517
3	354	664	64	600
4	269	588	482	106
5	316	564	324	240
6	349	746	439	307
7	474	900	516	384
8	212	450	288	162
9	478	869	610	259
10	421	837	797	40
Totals	3,721	7,049	3,777	3,272

This table should be interpreted as follows: Book No. 2, yielded 408 applications which were given 774 assignments to principles. Of these 774 assignments, 257 duplicated assignments resulting from Book No. 1, while 517 were new to the lists of applications already assigned from Book No. 1.

TABLE III  
CONTRIBUTION OF EACH SOURCE TO THE TOTAL NUMBER OF APPLICATIONS ASSIGNED TO ALL PRINCIPLES

Book	A	B	C	D
	No. Assignments Not Contributed by Any Other of the First Ten Books	Per Cent of Total Applications Not Contributed by Any Other of the First Ten Books ( $A/3,272 \times 100$ )	No. Assignments Not Contributed by Any Other of the Eleven Books	Per Cent of Total Applications Not Contributed by Any Other of the Eleven Books ( $C/3,403 \times 100$ )
1	198	6.1	197	5.8
2	235	7.2	226	6.6
3	174	5.3	141	4.1
4	59	1.8	48	1.4
5	143	4.4	132	3.9
6	225	6.9	205	6.0
7	247	7.6	207	6.1
8	144	4.4	94	2.8
9	182	5.6	157	4.6
10	41	1.3	36	1.1
11			131	3.8

This table should be interpreted thus: The assignment of applications resulting from the analysis of book No. 1, contributed 198, or 6.1 per cent of the 3,272 applications assigned to all principles as a result of the analysis and assignment of material from the first ten books. The assignment of applications from Book No. 11, resulted in decreasing the specific contribution of Book No. 1, to 197, or 5.8 per cent of the 3,403 applications assigned to all principles as a result of the analysis and assignment of material from the eleven books.

assignments which were not contributed by any other one of the eleven books analyzed. The effect of adding Book No. 11 is shown in Columns C and D of Table III.

A comparison of Columns C and D of Table III shows that the addition of the eleventh source tended to decrease slightly the percentage contribution of every source

to the total number of applications assigned to all principles. Column D of the same table shows that no one source contributed more than 6.6 per cent of the applications assigned to all principles. While it might be expected that if additional sources were selected according to the technique used in selecting Book No. 11, the percentage contribution of each source would continue to decrease, the results obtained by the addition of the eleventh book indicate that this decrease would probably be comparatively slight. The figures indicating the percentage contribution of each source are influenced by two factors of variability; namely, variation in the judgment of the investigator (1) in selecting applications from the pages of the texts analyzed and (2) in

assigning applications to principles. A careful check of the "reliability" of the investigator's judgment in selecting and assigning applications indicated that the percentage variations in selection and in assignment were somewhat greater than the percentage contribution of any one of the eleven sources. In recognition of these facts, it seems defensible to assume that the 3,403 applications assigned to principles as a result of the analysis of the eleven books are as representative as the limitations of the method permits of those applications which meet the investigator's criteria and which are commonly employed by authors of such sources as were analyzed.

(To be concluded)

## TEACHING NUTRITION: AN EDUCATIONAL OPPORTUNITY AND RESPONSIBILITY

JOSEPH HIRSH

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Malnutrition, strictly speaking, is neither a public health nor a medical problem. It has its roots in the total social situation. It is intimately related to economics—to poverty and unemployment, and to the cost and availability of foods. It is conditioned by psychological factors and customs, by habits of food selection and usage. It finds its political setting in wars, famines, migrations, and in agricultural programs and tariff policies. It is tempered and influenced by advertising and education, and by such distributive projects as the Food Stamp Plan and the Surplus Marketing Administration program.

Malnutrition is neither unique to any one group nor characteristic of the present national emergency. It strikes more than 40 per cent of our population—young and old, rich and poor. While the importance of the

problem is accented by the demands and stresses made upon all people in the present crisis, its roots go away back into history—back, in fact, to the planting of the first crops. It was brought into sharper focus when man began to "profit" from the civilizing influences of modern industry and city dwelling.

Today, one group of the American population, children of elementary, intermediate, and high school age—precisely that group going through the most critical stages of growth and development—are the greatest sufferers of malnutrition and undernourishment. Decayed teeth, one of the commonest evidences of nutritional deficiency, occurs in nine-tenths of all school children. In schools throughout the country, we find tens of thousands of children who, while not ill in a clinical sense, are in substandard

health—below normal in height, weight, physical stamina, and in resistance to disease. Their progress in school is slow. They are unable to concentrate. They have poor appetites. Many are dull and lethargic. Others are cross and fretful and frequently disciplinary problems.

These children are a standing indictment of all who are entrusted with the responsibility of the health of our people and the effectiveness of our educational program. Are our schools responsible for these children? Why, of course they are! Unless our school children are well-nourished, we might just as well close our school doors—permanently. Our educational system is wasting its money. You just cannot teach—successfully at any rate—children with half-starved bodies, hence half-starved minds.

If the function of the school is visualized as encompassing more than the inculcation of knowledge, skills, and attitudes and includes the development of the child in terms of the total social situation, it clearly follows that activities in the nutrition field are necessary. Here is an opportunity and a challenge.

The school's nutrition program should operate in the following three main areas:\*

1. Recognition by teachers and administrative personnel of substandard health conditions due to malnutrition and undernourishment. Where medical care is indicated, provision for the same should be made.
2. Establishment of a nutrition education program based upon local needs and patterns of food consumption.
3. Provision of one-third of the day's food requirements through a school lunch program supplemented where necessary or desirable by a mid-afternoon "snack."

In this paper, we shall be concerned with the detailed development of only one aspect of the school's program, namely, nutrition

\*For a broad discussion of all three areas, Cf. Hirsh, J., *Food for thought: The School's Responsibility in Nutrition*. U. S. Office of Education. Education and National Defense Series, Pamphlet No. 22. Washington: Government Printing Office, 1941.

education. To be truly effective, nutrition education should:

1. Reach the largest possible number of children. Specialized courses such as home economics are important—but malnutrition and substandard health do not merely strike students taking such courses. They are not restricted to the few, but strike many. It is mandatory, therefore, that nutrition education be made an integral part of many subjects.
2. Be both practical and realistic—recognizing limitations in income, local availability of various foods, and local patterns of food consumption and usage.
3. Be prosecuted throughout the entire school life of the child, beginning with the nursery school and running through the high school. To defer it until the junior or senior high school years would be much like trying to tile a roof before the foundation of the house has been laid.
4. Be intimately related with patterns of food usage in the home. It does little good, for example, to engender sound nutrition principles and practices in the school if they are nullified by what is done in the home at morning and evening meals.

In recent discussions of the character of nutrition education, an issue has been raised as to whether such education should be informal, formalized into units and courses of instruction, or strike some middle ground. In this writer's judgment, informal teaching seems most desirable at this time. It can be undertaken by all teachers and made an integral and functional part of all subjects. It is upon this premise, therefore, that the following outline is developed.

The teaching of nutrition must have as its basis the organization of all educational experiences. In order for children to have a functional understanding of nutrition, their needs must be defined in a clear-cut way. They can follow, in general, some such pattern:

1. Health is in part dependent upon good nutrition.
  - a. Prolonged lack of essential food and nutrients (vitamins and minerals) leads to disturbance of function and structure (disease) and to substandard health—weakness, lethargy, inefficiency, and lowered resistance to disease.
  - b. Optimal health depends upon the best combination of essential food nutrients.



2. Children and adolescents in particular are much interested in their growing and maturing bodies and in the multifarious factors which affect them.

- a. Physiological changes occurring in childhood and adolescence with their accompanying mental, emotional, and social implications call for vital education on two broad fronts—the biological and social.

Upon these two basic premises, major areas of teaching nutrition can be developed. The first area which, from the point of simplification, can be called the "social area" has as its pivotal point the individual and social importance of food and the abundant rewards sound nutrition practices offer in terms of human welfare. The following content outline, which is merely suggestive, comprises elements which can be incorporated in whole or in part, formally—in terms of units—or informally, in many social studies, for example, history, civics, elementary social living classes, economics and high school sociology. The following outline is broken down into subject-matter areas—many of which necessarily overlap.

#### *Personal and Public Health*

- I. Nutrition as a specific element in the total health picture has a definite relationship with growth, maturation, the maintenance of positive health, resistance to disease, the course of disease and convalescence.
  - A. What are the relationships between various types of diet and growth? Maturation? Length of life? Postponing senility?
  - B. What are the relationships between optimal, minimal intake and the absence of essential and protective foods and vigorous health? Substandard health, i.e., pre-clinical manifestations of disease (Weakness, lethargy, indifference or petulance, etc.)? Disease?
    1. How is the intake of these foods related to resistance to infectious diseases? Chronic diseases? To convalescence and recuperative powers?
    2. How is diet related to various types of deficiency diseases? Their incidence? Regional distribution?
  - C. What are the relationships between diet and efficiency at work? Attendance at school? Attitudes toward people?

II. Food is intimately related to many institutional aspects of public health work. It has an important place in the researches and operation of research institutions, hospitals, clinics, pharmaceutical companies, schools, and public health legislation, i.e., concerning food handlers, methods of preservation and transportation of food, sanitation of markets, restaurants, etc.

III. The effects of undernourishment and malnutrition are felt widely on the public health and on public funds.

- A. Undernourishment and malnutrition are among the chief causes of substandard health and lowered resistance to disease.
  1. They pave the way for many minor ailments—decayed teeth, coughs, colds, grippe, and the like—which are responsible for inefficiency and for millions of days lost from work, school, and other activities each year.
  2. They pave the way for such major disabling illnesses as tuberculosis and for such degenerative diseases as hardening of the arteries and kidney ailments.
  3. They are directly responsible for such deficiency diseases as pellagra, rickets, and scurvy.
- B. The direct and indirect results of malnutrition and undernourishment are costly.
  1. They are costly in the waste of private capital—time, money, and efficiency.
  2. They are costly in the expenditure of public funds—for the maintenance of hospitals, clinics, sanatoria, and other facilities and services.

#### *Food Practices and Home Life*

- I. Dietary habits and patterns of food composition affect many aspects of home life. In the past—before the mushrooming of large cities and the great advances in industry and commerce—many more people grew their own foods and subsisted on "whole" foods. Today, most people rely on large-scale commercial distribution of food, much of which is "refined" or stripped of its vital elements.
  - A. Patterns of food consumption vary widely, according to:
    1. *Different periods of time.* For example, many more people are drinking milk and eating certain kinds of fruits and vegetables today than forty years ago.
    2. *Geographic regions.* Certain staples in a New Englander's diet are consistent and are quite different from those in a Southerner's diet.
    3. *Custom and background.* Dietary prac-

tices are frequently handed down from generation to generation.

4. *The produce grown in various regions and the availability of different types of food.*

5. *Income.*

6. *Education.*

7. *Advertisements and fads.*

- B. Dietary habits and patterns of food consumption affect the economic and social structure of the family.

1. What part of the total family budget does food have?

- a. How does it vary with different income and social levels? In different regions?

2. How would a proper understanding of nutrition and intelligent purchases affect the food budget? The total budget?

- II. Diet is intimately related to physical well-being and to our attitudes towards various situations.

- A. Dietary requirements vary for different members of the family.

1. What are the requirements for expectant mothers? Infants? Children? Adults? The aged?

2. What are the relationships between diet and the peculiar needs of different individuals?

- a. How is the diet of a mother related to the development of her unborn child?

- b. How is diet related to the care of old people?

- B. Attitudes toward people and problems and mental health are influenced and, in part, conditioned by the foods we eat.

#### *Economics and Social Institutions*

- I. The production and distribution of food comprise one of the most basic enterprises in the country and has become established as important economic and social institutions.

- A. The food industry comprises the "growers" (farmers, cattlemen, etc.), the distributors and shippers, the "sellers" (retail merchants).

1. It comprises capital in the form of land, produce, buildings, trains, trucks, and vessels; plants for refrigeration and preservation; markets and stores.

- B. It is vitally interrelated to education programs, the mushrooming of fads, and advertisements.

- II. Food production and consumption are influenced by many factors. These are:

- A. Changes in the cost and standard of living.

- B. Agricultural policies and farm programs.

- C. Export and tariff policies.

- D. Disasters—wars, famines, drought and migrations.

- III. Food distribution and consumption are further influenced by consumer education of marketing and nutrition, evaluation of advertisements, and the establishment of community projects, i.e., community gardens, canning projects, Food Stamp Plans, school lunch programs, and general health-welfare programs.

#### *Miscellaneous*

- I. What, if any, is the relationship of diet with the evolution of present races from prehistoric races?

- II. How is diet related to the survival and hardiness of various peoples?

- III. What is the relationship of diet with differences of height and development of various races? Of different generations of the same race?

The second major area of nutrition teaching, the "biological area," contains elements which can be incorporated as units, lessons, or informally in biology, natural and general science, chemistry, and home economics classes. Obviously certain of these elements overlap the social sciences.

As a teaching area, it can be developed on the following working premises. Thus, the quality and quantity of food eaten is intimately related to physical well-being. Stated somewhat differently, the healthy need the right kind and amount of food to maintain health and to resist disease; the sick need it to resist further inroads of disease and to regain health. The continuous lack of essential foods\* results in maladjustments in function and, in children and adolescents, in body structure as well. Minimal essential foods provide only marginal health. Optimal essential foods provide mental and physical vigor.

- I. The body requires foods for energy.

- A. Energy is used by the body every moment of the day—during sleep as well as

\* These comprise vitamins, minerals, fats, carbohydrates, and proteins.

during waking hours, at rest as well as during periods of activity.

1. During rest periods, energy is spent to maintain circulation, respiration, digestion, muscular tone, and other vital processes.

2. Energy needs are influenced by age, sex, weight, activity, and climate.

a. These needs are measured in terms of calories.

3. Energy needs are met by the following foods:

a. *Carbohydrates*—in the form of glucose, stored in the liver temporarily as glycogen, or converted into body fat.

b. *Fats*—which may be used directly or stored as body fat.

c. *Proteins*—part of which may be used for energy, stored as body fat, and the largest part going into the building and repair of tissues.

B. The amount of energy-producing foods taken must not exceed greatly minimal needs.

1. An excess of such foods leads to indigestion, to fatness, or to both.

2. Such an excess limits the intake of other essential nutrients.

3. Minimal and subminimal food intake depletes the body of its normal stores of fats, other energy, and body-growth and repair substances.

II. The body requires foods for growth, repair, and reproduction.

A. Proteins are necessary for all normal cellular growth. An optimal supply is about 50 per cent over minimal need.

B. Minerals are also necessary for all normal cellular growth, and especially for the skeleton. An optimal supply (particularly of those needed in largest amounts, *i.e.*, calcium, phosphorus, iron) is from 100 to 300 per cent over minimal need.

III. The body requires certain protective and regulative foods.

A. *Vitamin A*—found in animal livers, milk, eggs, yellow vegetables and certain green vegetables, fish oil, and, of the fruits, apricots contain the most. Needed throughout entire life cycle. An optimal supply is four times that over minimal need. Lack of this vitamin contributes to the formation of kidney and ureter stones, and results in xerophthalmia and "night blindness."

B. *Vitamin B Complex* (contains at least six vitamins)—found in varying amounts in milk, eggs, whole grains, vegetables, and fruits. Needed in many processes.

An optimal supply is several times that over minimal need. Lack of different parts of this vitamin in varying degrees leads to a form of neuritis and general weakness called beriberi or polyneuritis; subnormal growth and poor appetite in children; constipation, dyspepsia, headaches, lack of stamina, and chronic fatigue in adults; a disease of the eyes, interstitial keratitis, commonly associated with syphilis; pellegra and many other conditions. Vitamin B, in a sense, is this generation's scientific substitute for the sulphur and molasses, bitters, and tonics of grandmother's day. It is effective in the treatment of the conditions listed. More important, it is a tonic even for well people. It is the "pick-me-up" without a letdown and in these days has been called the "morale" vitamin.

C. *Vitamin C*—found in fruits, vegetables, and milk. Needed by the body for normal nutrition. An optimal supply is several times that over minimal need. Lack of this vitamin leads to lowered resistance to disease, some anemia, subnormal rate of growth in children—some of the "latent" symptoms of scurvy. Severe scurvy—gums swollen and bleeding; teeth loose or falling out; rough, dry skin; bleeding under skin on legs, arms, and trunk—can be cured quickly by 1/1500 of an ounce of vitamin C taken daily!

D. *Vitamin D*—found in milk, fish oils, egg yolk, and butter. An optimal supply is several times that over minimal need. Needed by the body for the normal use of calcium and phosphorus. The most serious result of a deficiency of this vitamin is rickets.

E. *Vitamin E*—found in leafy green vegetables, wheat-germ oil, and in many other foods. Popularly misnamed the "anti-sterility vitamin," it is needed by the body (male and female) to produce sperm and ova. When the reproductive organs have been damaged by a continuous lack of Vitamin E, however, no amount will repair the damage in the male but it has beneficial results in the female—permitting pregnancy and preventing miscarriage.

F. *Vitamin G*—found in many foods. Needed for normal growth, nutrition, and vitality throughout life. An optimal supply is four to five times that over normal need.

G. *Vitamin K*—found in green leaves, spinach, alfalfa, and green cabbage. Needed by the body in certain diseases to prevent hemorrhage and to permit the clotting of blood.

- H. New vitamins and new functions of protective and regulative foods are being uncovered all along. These discoveries should be watched closely in the laboratory, hospital, and research institute. Their application for the benefit of all should be observed in the practices of food manufacturers, in food prices and advertisements, and in agricultural policies.
- IV. Every organ and organ system, every cell of the body, requires a continuous supply of food and oxygen to fulfill their life's process. Waste products resulting from these processes must be removed.
- A. After food is eaten, it must be digested and assimilated before it can be distributed for use in various parts of the body.
1. Digestion takes place in the stomach and intestines. Salivary juices, gastric juices and enzymes, bile, pancreatic enzymes, and intestinal juice containing enzymes are responsible for digesting food.
  2. Digested food (carbohydrates and proteins) passes through the intestinal wall directly into the blood stream and is distributed throughout the body.
    - a. Digested fats first pass into special vessels, the lacteals, thence into the blood stream.
    - b. Undigested food passes through the large intestine and out of the body as waste.
- B. Every cell in the body oxidizes the food and releases energy.
1. Vital processes (growth, repair, reproduction, etc.) are continually going on.
  2. Food is required in all of these processes.
  3. Wastes are continually created in these processes.
- C. Blood and lymph bathe the cells of the body, allowing the passage of materials to and from them.
1. Sugar in the form of glycogen from the liver; fats, amino acids (break-down of proteins), minerals, and vitamins from the digestive tract pass into the blood and are distributed to the cells.
  2. Oxygen from the lungs pass into the blood, thence, to body cells.
  3. Water from the digestive tract and from the body cells (resulting from the oxidation of food) passes into the blood, thence to the lungs, kidneys, and sweat glands where they are excreted.
4. Carbon dioxide from the body cells pass into the body and is excreted from the lungs.
  5. Nitrogenous wastes from the body cells are distributed through the blood to the kidneys where they are excreted.
- V. Foods are classified both according to the essential nutrients they furnish and their health-giving values.
- A. Grain products (bread and cereals) provide economical sources for energy and tissue building.
1. Much of the vitamin and mineral content of grains is present in the outer coat or bran, and in the embryo or germ. These values are lost in all but "whole" cereals and "whole" wheat breads. In other grain products they are being replaced by "enriching" the foods with vitamins and minerals.
- B. Fats are important as the sources of energy and vitamins A and D.
- C. Sugars are economical sources of energy.
- D. Muscle meats, fish, and poultry are good sources of protein and fat but not of vitamins and minerals.
- E. Fruits and vegetables furnish vitamins and minerals abundantly.
- F. Milk and eggs are perhaps the two most important single sources of vitamins and minerals.
- VI. Careful selection of foods and sound nutrition practices add to:
- A. Optimum health and vigor.
  - B. Resistance to disease.
  - C. Preservation of youth and prolongation of the prime of life.
- Nutrition can be further developed, on the basis of the preceding outline,\* so that it can become the focal point about which most or all of a biology course can revolve. With few exceptions, all of life's processes can be explained in terms of nutrition.

#### SUGGESTED BIBLIOGRAPHY

##### *Books and Monographs*

1. Bingham, N. E. *Teaching Nutrition in Biology Classes*. Bureau of Publications, Teachers College, Columbia University, New York, 1939. 117 p.

Based upon the question: "Can the study of the relation of food to physical

\*For a more elaborate discussion of the biological area, Cf. Bingham, N. E., *Teaching Nutrition in Biology Classes*. Bureau of Publications, Teacher's College, Columbia University. New York, 1939. Pp. 137, which served as the basis for the material presented above.

well-being in high school biology classes be truly educative?" It is fundamentally a report of special situations but contains good suggestive lessons on nutrition for all secondary classes and bibliographical references.

2. Borsock, H. *Vitamins: What They Are and How They Can Benefit You*. Viking, New York, 1940. 193 p.

This is a cook's tour of the vitamins, explaining what they are, where they are found, and what they do for us. The appendix contains practical menus for various age groups (for those who eat at home and in restaurants) and tables of vitamin containing foods. It can be read profitably by children in the upper elementary grades, in the secondary schools, by teachers and parents.

3. Cummings, R. O. *The American and His Food*. University of Chicago Press, Chicago, 1940. 267 p.+12 illustrations.

This is an excellent history of patterns of food consumption, the development of nutrition science, and of the historical inter-relationships of food with economics, politics, migrations, transportation, and social programs. It is good source material for teachers and can be recommended as suggestive reading for upper grade high school students.

4. Roberts, L. J. *Nutrition Work with Children*. University of Chicago Press, Chicago. 2nd ed., 1935. 639 p.+charts and illustrations.

This is essentially a text and reference book for teachers and other trained personnel. It extends beyond Dr. Rose's "Foundation of Nutrition" in that it shows how teachers can contribute to the solutions of malnutrition through education on various levels. Further, it cites various public and voluntary agencies concerned with the nutritional betterment of children. As a source book, it should be read simultaneously with Dr. Rose's book or immediately afterward.

5. Rose, M. S. *The Foundations of Nutrition*. Macmillan Company, New York. Rev. ed., 1935. 630 p.+illustrations.

Is a non-technical text of fundamental principles of human nutrition. Good background material for teachers and elective reading for secondary school pupils.

6. Rose, M. S. *Teaching Nutrition to Boys and Girls*. Macmillan Company, New York, 1932. 198 p.+32 illustrations.

This book represents the actual experiences of teachers engaged in teaching nutrition in the elementary and intermediate grades. It serves as "a practical guide for . . . teachers who wish to promote health through intelligent use of food" and

includes units of instruction and lesson plans.

#### Leaflets and Pamphlets

7. *Are We Well Fed?* Miscellaneous Publication 430, Bureau of Home Economics, U. S. Department of Agriculture, Washington, p. 28.

In simple, concise terms—with charts—it portrays graphically the nutrition problems of the country and the job that has to be done—if we are to be well fed.

8. *Diets to Fit the Family Income*. Farmers' Bulletin No. 1757, U. S. Department of Agriculture, Washington, 1936, p. 37.

Describes four types of adequate diets to fit different income levels and family groups. Classifies main groups of food in these diets according to function and health value. Provides a week of sample menus for each diet plan and tables for making weekly market lists.

9. *Eat the Right Food to Help Keep You Fit*. Folder. Bureau of Home Economics, U. S. Department of Agriculture, Washington, p. 4.

Lists major food groups and quantities everyone requires.

10. *Facts about School Lunches*. Leaflet SMA, SL-6, Surplus Marketing Administration, U. S. Department of Agriculture, Washington, 1940, p. 4.

Describes the organization of the school lunch program; how schools become eligible to receive surplus foods; how they are to utilize them, and other pertinent questions.

11. *Menus and Recipes for Lunches at School*. Miscellaneous Publication No. 246. U. S. Department of Agriculture, Washington, 1936. Pamphlet. 24 p.

This manual gives menus and recipes and methods of preparing various dishes for lunches at school. Included is an important section on the nursery school and a discussion on purchasing suggestions.

12. Rowntree, J. I. *This Problem of Food*. Public Affairs Pamphlets, No. 33. Public Affairs Committee, New York, 1939. 32 p.

Covers the broad problem of nutrition as it affects various social, economic, and regional groups. Classifies foods according to specific nutritional requirements of the body. Suggests aids in food selection and budgets.

13. *School Lunches Using Farm Surpluses*. Miscellaneous Publication No. 408. U. S. Department of Agriculture, Washington, 1940, p. 48.

Gives specifications of well-rounded school lunch and suggests six types of menus. The major elements of each menu are discussed individually with reference



to methods of preparing them for various kinds of dishes and different quantity servings.

14. *Well-nourished Children*. Folder 14. Children's Bureau, U. S. Department of Labor, Washington, 1939, p. 16.

Explains the importance of food for growing children. Food requirements are classified according to groups, quantities, and health qualities. Suggests a daily check list of nourishing foods for growing children.

## THE MAN WITH THE TELESCOPE \*

GLORIA GUÉ

*Eighth-Grade General Science Student  
Memminger High School, Charleston, S. C.*

*Editor's Note: The following play was submitted to us for publication by Miss Marion H. Stucke, of Charleston, South Carolina. We quote here a part of Miss Stucke's letter with the thought that her motive for sending the manuscript to us is its best introduction.*

*"During the study of a unit of astronomy in my eighth grade general science class, one of my students, Gloria Gué, wrote the enclosed play. The class enthusiastically presented it as an auditorium program. Because there is a dearth of such material for general science clubs and classes, I am sending the play to you. The class and I hope that you will like it enough to publish it."*

### Scene 1

*Place:* A church in Pisa, Italy  
*Time:* The sixteenth century  
*Characters:* Galileo  
Galileo's friend  
Priest  
Congregation

### Scene 2

*Place:* Galileo's study  
*Time:* The next evening  
*Characters:* Galileo  
Tony, his friend

### Scene 3

*Place:* The leaning tower of Pisa in Italy  
*Time:* The sixteenth century  
*Characters:* Galileo  
President of the University  
Two other men

### Scene 4

*Place:* Hans Lippershey's spectacle shop in Holland  
*Time:* The sixteenth century  
*Characters:* Hans Lippershey  
His two sons  
Lady  
Nobleman

### Scene 5

*Place:* In Galileo's garden  
*Time:* Evening  
*Characters:* Galileo  
Two friends

\* Based on a copyrighted article "How They Blazed the Way" by J. Walker McSpadden. Used by courtesy of Target.

### Scene 6

*Place:* A council room  
*Time:* Morning  
*Characters:* Galileo  
Judge  
Members of the council  
High school girl  
*Committees:* Property  
Managers of curtains and lights  
Ushers  
Stage  
Program

*Announcer:* Presenting The Man with the Telescope. . . . In the year 1564 a man by the name of Galileo was born. He was born at a time when the whole civilized world — and that meant Europe — was pressing eagerly forward in the arts, science and discovery. Ships of all the nations were following in the wake of Columbus, Vasco da Gama, Magellan. Maps were beginning to show what the world really looked like. Printing had been put into practice now for a hundred years, and books were becoming plentiful. But many scholars were still basing their philosophy on Aristotle over a thousand years back or their astronomy on Ptolemy, who was still more remote. Let

us look in on Galileo one Sunday when he is in church. (Exit announcer.)

## SCENE 1

(Properties for this scene include chairs for the congregation, a Bible and a lectern or table to hold the Bible. The priest stands behind the lectern and the congregation is seated on the other side of the stage. Costumes may consist of bloomers or knickers, blouses, capes, small hats with feathers or plumes, black stockings and shoes. Women characters may wear almost any type of long dress with a scarf over the head and shoulders or more elaborate Elizabethan costumes may be used.)

*Priest:* Let us pray. (Priest appears to pray while the congregation kneels. The lamp to which Galileo refers may be left to the audience's imagination. Galileo and his friend look up as if looking toward the swinging lamp which is suspended from the ceiling of the church.)

*Galileo:* Look! Do you see that lamp over there? Watch how it swings back and forth.

*Friend:* Haven't you even seen a lamp do that before?

*Galileo:* Of course, but notice that although it is slowing down, it still uses the same amount of time in its forward-backward movement.

*Friend:* How can you tell?

*Galileo:* See, I'm putting my finger on my pulse and I can time the swing against the beat of my pulse.

*Friend:* Man, you're crazy. Oh, by the way, I think we should be praying. Just for a little advice, pray God to give you some sense. You certainly need it.

*Galileo:* Oh, I'm sorry. We should be praying.

*Priest:* May the grace of God be with you. (People leave the church.)

*Friend:* Aren't you coming? (Galileo is gazing in direction of the lamp.)

*Galileo:* Oh, yes, I'm coming. (Exit Galileo and friend.) (Close curtains.)

## SCENE 2

*Announcer:* Next we find Galileo in his study the following day. Galileo is still thinking about the swinging lamp he saw in church the day before. He is now trying to make a device—a pendulum clock—to be used in telling time.

(When the curtains open, Galileo is sitting at a table writing. He stops to swing an object suspended by a cord and seems to be studying its movements. Tony enters.)

*Tony:* Galileo, how about going to see a play with Maria and me? That English writer named Shakespeare has written another play. It is called *Romeo and Juliet*. A group of players are presenting it tonight.

*Galileo:* I'm afraid I can't go, Tony, because *this* is important. It might prove big. Just think, you might be using this some day instead of the sun dial or the hour glass.

*Tony:* Ever since you came from church yesterday you seem to ignore me and what I say and you interest yourself in this drawing of swinging objects. I don't like it, and besides I don't think it makes sense.

*Galileo:* Now, Tony, please don't think hard of me. I know I should talk with you more, but when you ask me to put down my work, something great, to go to this play. Probably it will be no good.

*Tony:* Those pieces of paper and that swinging object great? My dear Galileo, are you sure you feel well?

*Galileo:* I wish you could understand science, Tony.

*Tony:* I wish so, too, but since I can't—well, what do you say about the play?

*Galileo:* I'm sorry, but I must go on with my work. You go now, and I'll drop by your house as soon as I finish.

*Tony:* All right.

*Galileo:* I'll see you later. Say hello to Maria for me.

*Tony:* Of course, good-bye.

*Galileo:* Good-bye.

(Pause)

*Galileo:* (excitedly) I've found it—the secret of the pendulum. Now I *know* people will use this clock instead of the sun-dial or the hour glass.

(Close curtains.)

### SCENE 3

*Announcer:* Galileo is now a teacher at the University of Pisa. At the university he is required to teach what Aristotle first taught a thousand years before—namely, that when an object falls, the heavier the object, the greater the speed with which it falls. Galileo did not believe this, and in the next scene we find him with the president of the university and two others in front of the leaning tower of Pisa where they have come to settle the dispute.

(Properties for this scene include a book, two wooden balls—one large and one small—arranged in a box so that the box may be tilted and the balls will roll out together. The box is not essential, but it was used by Galileo. A hammer and a block of wood is needed off stage to make a sound to represent the falling of the balls. As Galileo leaves, he places the balls just back of the side curtains so that when they are picked up by the gentlemen, the audience will suppose that they have been dropped from above.) Galileo and others are on the stage as the curtain opens.

*Galileo:* Well, gentlemen, you don't believe me?

*1st man:* But are you trying to dispute Aristotle? Here it is in the book (points to open book he is holding) that if two objects are dropped at the same time, the heavier one will hit the ground first.

*2nd man:* Can you prove your theory, Galileo?

*Galileo:* Yes, I can prove it.

*President:* But how, how can you prove this stupid idea?

*Galileo:* I shall climb to the top of this tower. I shall drop these two balls, one

weighing one pound, the other weighing three pounds. I shall prove to you, gentlemen, that my idea is not wrong but right.

*President:* That seems fair enough. We shall wait here while you go to the top of the tower. (Galileo leaves the stage.) Watch him fail. He can't possibly prove this idea.

*Galileo,* speaking from off stage: Are you ready, gentlemen? (They look up.)

*President:* Proceed.

*Galileo:* Watch the balls. I am going to drop them. (Men gradually lower their eyes as if watching balls as they fall.) Sound is made off stage. First man runs to curtain, picks up balls and brings them to the president.

*President:* Why, they both hit the ground at the same time. This is unbelievable. There must have been some trick.

*Galileo,* coming in breathlessly: But there is no mistake. Does that prove that Aristotle was wrong?

*President:* Galileo, your ideas are stupid. Here are your balls. (Hands Galileo the balls.) You shall no longer teach at the university.

*Galileo:* But, sir. . . .

*President:* That is all! Come, gentlemen. (Gentlemen leave. Galileo is left standing alone with his balls, amazed and dejected.) Close curtains.

### SCENE 4

*Announcer:* Let us now turn to Holland to a little spectacle shop—Hans Lipper-shey's shop. Hans is grinding lenses while his two sons are amusing themselves looking through other lenses.

(Properties include 4 lenses, a piece of cardboard rolled or a small piece of iron pipe to represent the first crude telescope, money, table and chair.)

Curtain opens.

*Hans:* Oh, what a bad day for business. No customers, no customers.

*Lady*, entering: Good morning, Mr. Lipershey. I've been having a terrible time with my eyes; so I finally decided to get some spectacles.

*Hans*: Good morning, madam. Try this lens. (He holds a lens to her eye.)

*Lady*: No, I couldn't use that.

*Hans*: How is this one? (He tries another.)

*Lady*: This one is much better. (She looks toward side of stage.) Now I can see the leaves on the tree by your window. (Hans's sons mimic the lady, holding up lenses and looking toward window.)

*Hans*: I can make you up a pair of spectacles in the very latest style for only twenty-five dollars.

*Lady*: Cost means nothing, my man. When can I get them?

*Hans*: I'll have them ready for you by tomorrow.

*Lady*: I'll come in tomorrow for them. Good-day. (Lady leaves.)

*Hans*: Good-day, madam.

*1st boy*, looking through two lenses: Father, father, look! The weathercock from our neighbor's house seems to come into the shop.

*2nd boy* (excitedly): Let me see; let me see! (Nobleman enters.)

*Hans*: So it does. But how can that be!

*Nobleman*: What's all the excitement, friend?

*Hans*: When you look through these lenses, the weathercock seems to come into our shop. Here, look.

*Nobleman*: Why, all things seem to come into the shop. How strange. I've been looking for something to take to my friend, the Prince of Nassau in Italy. Perhaps he might like this. Can you put these lenses together for me?

*Hans*: Yes, I can try. (Puts a lens in each end of a tube or pipe. If lenses do not fit the tube, the audience should get the impression that they are in the tube

when it is handed to the nobleman.) Here, how is this?

*Nobleman*: How much do I owe you?

*Hans*: It is only a toy, sir. Would five dollars be too much?

*Nobleman*: Indeed, not. It is an interesting toy. It will amuse my friend, I am sure. Good day, sir.

*Hans*: Thank you and good day to you, sir. (Curtain.)

# SCENE 5

*Announcer*: Galileo chanced to hear about the tube which had been brought from Holland to the Prince of Nassau in Italy. His keen mind went to work. Taking a small organ pipe about three feet long, he placed in it the lenses which he had ground himself. He was delighted to find that he had an instrument which would magnify distant objects about three times.

(Properties: telescope or long cardboard tube. Blue lights are good for this scene if they are available). Curtain opens.

*Galileo*: Let us look at the moon tonight, gentlemen.

*1st friend*: The tube is marvelous, Galileo, but you have been looking only at the small things on earth. As you know, the moon is many miles away.

*2nd friend*: But there is nothing to see on the moon. It is as smooth and shiny as a silver plate.

*Galileo*: So I thought until I looked through this telescope. But suppose you look for yourself.

*1st friend*: Let me look first.

*Galileo*: All right. Look through here.

*1st friend*, looking through telescope: Why, there are mountains and craters and valleys on the moon the same as on our earth!

*Galileo*: Exactly! You are, in fact, gentlemen, observing another world!

*2nd man*: Let me look. (He looks through telescope.) How amazing!

*Galileo*: Now look at Jupiter.

*2nd friend*: Where?

*Galileo*: Over there.

*2nd man*, observing Jupiter: What are those four little points of light near Jupiter?

*Galileo*: Those are Jupiter's four moons.

*Men*, together: Moons!

*Galileo*: Yes, for many nights now I have watched them disappear behind Jupiter and reappear on the other side.

*1st friend*: May I look now? How strange! To think that Jupiter actually has four moons. (Looks at Jupiter.)

*Galileo*: Yes, and no telling how many more moons there may be. I am convinced that Copernicus was right. The sun must be the center of the solar system with the earth and other planets moving around it. I'm going to write pamphlets about what I have discovered.

*Men*: Yes, that is a good idea, Galileo.

*1st friend*: I must be going now, but may I come again and look through your new instrument, Galileo?

*Galileo*: Indeed. Come any evening. You'll find me with my telescope.

*2nd friend*: This has been a most interesting experience, Galileo. Good night.

*Galileo*: Good night.

*1st friend*: Good night. (Starts to leave, but hesitates and comes back.) Galileo, be careful about what you write concerning your discovery. There are many people who will not believe you if you say that the sun and not the earth is the center of the known universe. You may lose your head (draws finger across his throat and laughs jokingly) if you are not careful.

*Galileo*: Even if I lose my head, my friend, I must tell the world that Copernicus was right. The earth moves around the sun. All the planets move around the sun. How little we know about our earth and the planets, the sun and the

stars. How much we have to learn. Thank you for your advice, but I can't promise to keep silent as Copernicus did. Good night. (Close curtain.)

#### SCENE 6

*Announcer*: Galileo did write those pamphlets. Now he was getting old. Still many people did not believe him. They had called him before the council on other occasions. Now he is before the council again—an old man of sixty-nine years.

(Properties: Table for judge, gavel, chairs for judge, Galileo and for 3 or 4 men who represent the council.) In this scene, Galileo is a bent old man. He walks with a stick. (Open curtains.)

*Judge*, in a very stern voice: The council will come to order. Will the defendant please rise? Galileo, as you know, you have been before this council before. We asked only of you not to repeat that the earth moves around the sun. How could you, a man of learning, think such a crazy thing! Now we shall come to the point. Either recant your statement or be tortured.

*Galileo*: May I say something, sir?

*Judge*: Yes, yes, go ahead.

*Galileo*, slowly and with feeling: Thank you. Gentlemen, I'm old. I tire easily. I can't write as many books about my beliefs. My eyes are not as good as they used to be. But why should I bemoan the loss of my eyes? They have seen more than any son of Adam. To you, I leave my new eyes. Through my telescope, you may explore the new worlds as long as time shall last. Now you ask me to recant all the things that I have based my life upon! (Pause.) You have the advantage over me. (Slowly Galileo kneels.) I recant! (He remains kneeling until the end of the scene.)

*Judge*: That is well, Galileo. That was the best you could have done. (Judge



and council men leave. Galileo remains kneeling.)

*Galileo:* But I still think that the earth moves around the sun. (Pause. Present day school girl enters.)

*High School Girl:* Galileo, I am a high school girl of the twentieth century. The people of the sixteenth century did not know that you were right in your beliefs. They did not appreciate what you did for mankind. But how could they know that you were right? We cannot blame them for thinking that your ideas were stupid. They were just emerging from the dark ages. They were bound by fetters of ignorance and superstition. They did not have the splendid educational opportunities that we enjoy today.

We know now, Galileo, that you were right and that they were wrong. We are grateful to you and to other men like you who have brought us to a new understanding of our earth and its part in the solar system. We are grateful to

you, Galileo, for your inventions and discoveries—for the pendulum clock, for the new law about falling bodies, for the telescope which you improved and first used to study the stars and planets.

Though you found no word of encouragement or comfort in your day, we of this generation honor you and sing your praises. (The group of pupils who have taken part in the preceding scenes step to the center rear of stage and sing the closing song. This may be made more effective if there is a rear curtain which may be opened to disclose the group already assembled.) Closing song:

Hail to thee, O Galileo,  
Great astronomer;  
All hail to thee, O Galileo,  
Great inventor.  
Generations honor thee,  
Praise thee for thy works;  
All hail to thee, O Galileo,  
Great astronomer.

(Close curtain.)

## LOCALLY CONSTRUCTED APPARATUS FOR USE IN HIGH SCHOOL PHYSICS

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The purpose of this article is to stimulate physics instructors to make their own apparatus and to encourage their students to make their own equipment. A table of classified references which give directions for making simple physics apparatus is herein presented. Specific directions for making a few items are also included as examples of what might be done. It has been said that the price of survival in modern business is eternal research. It is no less true in other lines of endeavor including the teaching of physics. The classroom science teacher has the opportunity if not always the time, to improve science teaching tech-

niques by contributing new apparatus for laboratory and demonstration.

The values of making apparatus locally have been debated with various results, but it all may be condensed as follows: Many schools with limited science equipment budgets cannot afford to buy necessary apparatus. The construction of apparatus has a beneficial effect on the one making the item, whether he be student or teacher. These two statements represent the two factors favoring the subject, i.e., economic and educational. On the other hand the principal negative arguments question the efficiency of home made apparatus and the

time needed to make it. The reader may judge for himself on the advisability of making apparatus locally and also get some ideas for making equipment by reading the references listed at the end of this article.

The list of apparatus references presented in the table is the result of the examination of all available references. It is expected that the instructor who examines the list may find an item which will suit his particular need or the need of his student. The items have been classified according to the divisions of subject matter of high school physics. The magazines and books given as sources may be found in the majority of university libraries and teachers' college science departments.

There is considerable variation in the types of apparatus in the table. There are many items of equipment which might be used as substitutes for ready-made apparatus. Examples of such items are the galvanometer, vacuum pump and telegraph sounder. Another type is that equipment which does not appear in the scientific company catalog because the apparatus is not commonly sold to high school science departments. Examples of this type are the geyser, reaction timer and television principle demonstrator. In order to put the table in a small space the references are indicated by the following symbols:

B—Beauchamp, W. L., Mayfield, J. C., West, J. Y. *Science Problems, Book 3*. Chicago: Scott, Foresman and Company, 1939.

CD—Cook, S. G., Davis, I. C. *A Combined Laboratory Manual and Workbook in Physics*. New York: Mentzer, Bush and Company, 1936.

CGS—Clark, J. A., Gorton, F. R., Sears, F. W. *Physics of Today*. Cambridge, Massachusetts: Houghton Mifflin Company, 1938.

CGSP—Clark, J. A., Gorton, F. R., Sears, F. W. *Physics Laboratory Manual*. Cambridge, Massachusetts: Houghton Mifflin Company, 1938.

H—Henderson, W. D. *The New Physics in Everyday Life*. Chicago: Lyons and Carnahan, 1930.

HP—Henderson, W. D. *New Physics Guide and Laboratory Exercises*. Chicago: Lyons and Carnahan, 1936.

LHW—Lake, C. H., Harley, H. P., Welton, L. E. *Exploring the World of Science*. New York: Silver Burdett, 1939.

MGC—Millikan, R. A., Gayle, H. A., Coyle, J. P. *New Elementary Physics*. Boston: Ginn and Company, 1936.

S—Sutton, R. M. *Demonstration Experiments in Physics*. New York and London: McGraw Hill Book Company, 1938.

SSM—*School Science and Mathematics*, I-XL, (1901-1940).

W—Williard, L. R. *Experiences in Physics*. Boston: Ginn and Company, 1939.

TABLE I

LIST OF REFERENCES FOR LOCALLY CONSTRUCTED PHYSICS APPARATUS \*

Apparatus	Source	Page
<b>A. Electricity, Current</b>		
Buzzer or bell	W	506
Electric key	SSM IX	353
Electro-calorimeter	S	322
		366
Electrolysis	B	469
Electrolytic rectifier	HP	283
Fuse device	SSM XVII	120
Fuse, mercury	S	311
Galvanometer	B	286
	CGSP	116
	SSM II	285
	SSM XXI	770
Heating effect of current	SSM II	519
Multi-range voltmeter	SSM XX	459
Parallel resistance problems device	SSM XXIX	998
Poor gas conductivity	SSM VII	664
Portable units	SSM XXXVI	974
Principle of rectifier demonstrator	SSM XL	109
Resistance boards	W	536
Resistance box	SSM V	268
Telegraph	B	461
Telegraph sounder	W	506
Wheatstone bridge	SSM XXXVI	1017
	S	316
Wheatstone bridge model of water	SSM XXX	528
<b>B. Electricity, Static</b>		
Electric chimes	S	266
Electric whirl	S	434
Pith balls electrostatics	SSM VI	672
Smoke precipitator	S	434
Sulfur electrophorus	SSM XXXVI	714

\* This table should be interpreted as follows: Select the desired item—for example, "Electric key." SSM indicates School Science and Mathematics magazine as the symbol in the list above the table shows, IX is the volume number, and the page is 353 in that volume.

TABLE I—(Cont.)

LIST OF REFERENCES FOR LOCALLY CONSTRUCTED  
PHYSICS APPARATUS \*

Apparatus	Source	Page
<i>C. Electromagnetic Induction</i>		
Audio frequency oscillator	S	162
Climbing spark, one connection tube light, fuelless motor	SSM XXVII	835
Cycles of alternating current demonstrator	SSM XL	333
Electric motor	LHW	462
Electric stop clock	SSM XL	277
High frequency coil	SSM IV	151
Hot dog heater	S	321
Induction apparatus	SSM XII	332
Motor	CGSP	128
Transformer	SSM V	551
<i>D. Gases</i>		
Advantage of streamline	S	121
Anemograph	SSM IV	159
Atomizer	W	110
Boyle's law	SSM V	49
	SSM XIII	544
	SSM XXII	396
Diffusion of gases	SSM XIV	40
Gasometer	SSM XII	376
Mercury vacuum pump	SSM XXXVIII	376
Pressure gauge	W	60
Shadow projection of carbon dioxide gas	S	121
Simple barometer	SSM XIV	568
Water barometer	SSM XV	481
<i>E. Heat</i>		
Arc lamp	LHW	469
Candle flame	S	198
Conductometer	SSM VII	473
Convection current box	W	308
Convection currents	SSM XXXI	454
Cylinder model	S	271
Engine cylinder	W	347
Gas engine cylinder model	CGS	334
Geyser	SSM III	288
	SSM XIV	410
Heating system model	S	237
Heat generated by spark	SSM XL	272
Light out by heat	S	316
Linear expansion	CD	89
	S	198
	SSM VI	779
Linear expansion meter	W	257
Model fire sprinkler	SSM XV	77
Model steam heating plant	SSM XXXII	1018
Pie-tins clutch	W	354
Reflecting cones	W	294
Steam engine model	SSM V	279
Steam turbine	B	528

TABLE I—(Cont.)

LIST OF REFERENCES FOR LOCALLY CONSTRUCTED  
PHYSICS APPARATUS \*

Apparatus	Source	Page
Sun ray apparatus	SSM IV	146
Thermostat	S	201
		215
Tin-can steam engine	SSM XXI	732
<i>F. Light</i>		
Color mixer	SSM XL	277
Continuous colored flame	SSM X	642
Eye model	S	394
Interference (soap film)	S	395
Interference of light	MGC	499
Inverse square law	S	373
Lantern slide making	SSM XL	165
Light wave interference	SSM XV	534
Micro-projector	SSM XXXVII	933
Motion picture model	SSM XXXIX	339
Photo-electric effect	CGS	622
Photo-electric marble sorter	SSM XL	277
Polariscope	SSM VII	484
Reaction timer	SSM XXXVI	578
Refraction by shadow	S	381
Rumford photometer	MGC	493
Simple oscillograph	SSM XXXV	583
Spectrometer	SSM II	33
Spectroscope box	SSM XXII	40
Stroboscopic projector	SSM XXXVII	260
Telescope	SSM XXXVII	643
<i>G. Liquids</i>		
Automatic still	SSM XVII	134
Blood pressure measure	SSM XXVIII	730
Calibration of hydrometer	H	68
Fountain siphon	S	111
Hydrostatic paradox	HP	28
	SSM IX	26
Ink bottle specific gravity bottle	W	82
Intermittent siphon	S	110
Water level	W	37
	SSM V	171
<i>H. Magnetism</i>		
Dipping needle	CGS	493
	SSM VII	466
Iron filings tube bar magnet	W	497
Making a magnet	S	303
<i>I. Molecular Mechanics</i>		
Atomic structure board	SSM XXXVI	190
Drop formation by stroboscope	S	104
<i>J. Physics Tools</i>		
Display case	SSM XXXVI	592
Six foot demonstration slide rule	SSM X	776
	SSM XV	417

TABLE I—(Cont.)

## LIST OF REFERENCES FOR LOCALLY CONSTRUCTED PHYSICS APPARATUS \*

Apparatus	Source	Page
<i>K. Radiations</i>		
Electrical resonance	W	626
Geissler tubes from light bulbs	SSM X	639
Radio by steps	W	628
Television principle	SSM XXXVIII	813
Vacuum tube by hydraulic analogy	SSM X	639
<i>L. Solids (1) Acceleration, Motion Pendulum</i>		
Acceleration	CGS	156
Acceleration of gravity apparatus	CGS	140
Concurring forces	SSM VII	48
	SSM XI	272
Falling bodies	SSM VII	403
Falling bodies gun and target	SSM XXXI	1098
Fall independent of mass	S	39
Harmonic motion	S	129
Inertia ball	W	166
Laws of motion apparatus	SSM XXXIV	34
Low velocity projection	S	26
Magnetic release falling body	SSM XVI	435
Model of earth	SSM XXXIX	513
Paper saw	S	62
Path of projectiles	SSM XII	194
	SSM XIII	224
Resultant movement	S	38
Stable equilibrium	S	26
Vector apparatus	SSM V	191
<i>M. Solids (1) Machines, Friction</i>		
Friction experiment	SSM V	110
Inclined plane	SSM VI	44
Wheel and axle	W	210
<i>N. Sound</i>		
Compressional wave	W	368
Electric tuning fork	S	157
Longitudinal waves	SSM VII	687
Manometric flame	MGC	442
	S	165
Musical scale and harmony apparatus	SSM XXVIII	9
Phonoscope	S	166
Ripple tank	S	149
Sonometer	MGC	459
Tin-can talking machine	SSM XXXI	730
Vibrating strings	SSM XII	560

The drawings of apparatus which follow may or may not be new to the reader. They are indicative of simple apparatus which

may be easily made and also increase the efficiency of one's teaching.

This is a water model of a wheatstone bridge. It is made of glass tubing, rubber tubing and pinch clamps. The purpose of the Y tube at the top is to admit air bubbles to make the flow visible.

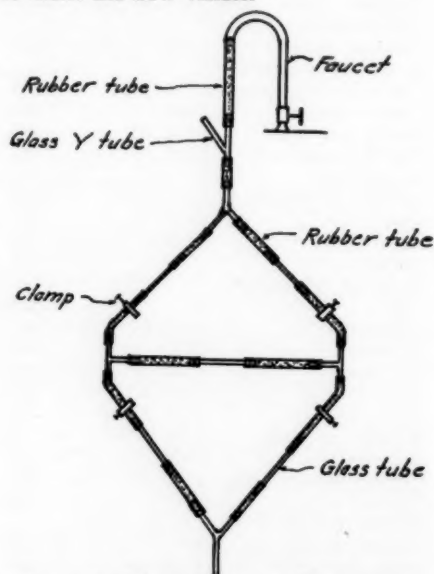


FIGURE 1.—WATER MODEL OF WHEATSTONE BRIDGE

In studying the vacuum tube a discarded one is too small for a demonstration and a little hard for the beginner to understand. A large model makes an efficient demonstration possible.

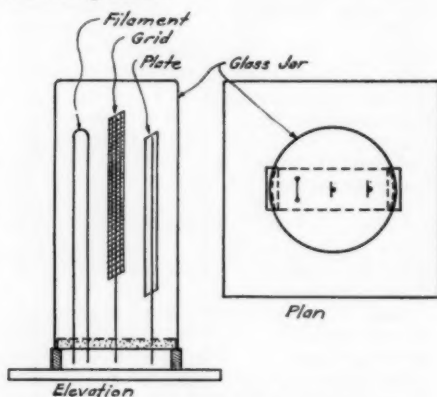


FIGURE 2.—RADIO TUBE MODEL

The base is made of wood about 1 in. x 8 in. On the base are mounted two blocks, each 1 x 2 x 3. On top of these blocks is nailed a piece of wood which has a length determined by the diameter of the glass jar's mouth, is 1 in. thick and about 2 in. wide. In this same piece four holes are drilled—one for the plate wire, one for the grid wire and two for the filament wires. The filament is represented by a large wire in the shape of a 6 in. long inverted U. The grid is a rectangle of wire screen to which is soldered a heavy wire. The plate may be a rectangle of tin to which is soldered a heavy wire. When these three pieces are inserted into the holes drilled in the top block and a glass jar is inverted over them, a model of a simple three element vacuum tube is ready for demonstration.

A carbon arc furnace may be made from two bricks, two carbon rods and a source of current. The middle of one side of each brick is hollowed out so that a depression about the size of half an egg is formed. Leading from the depression to each side a ditch is formed one-half the size of the carbon rods. When the two bricks are put

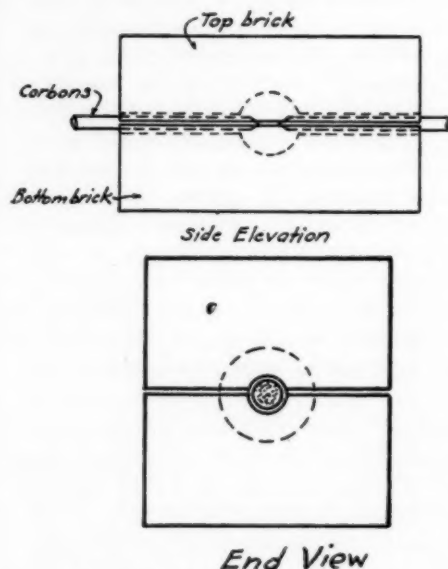


FIGURE 3.—CARBON-ARC FURNACE

together a hollow the size of an egg or smaller is formed with a hole opening on each side into which the carbons may be inserted.

A full vision color mixer adds special interest to the study of color. A simple frame for holding a white sheet of cardboard can be made from three sticks and a wooden base. Colored sheets of paper may be held against the white cardboard or permanently glued to cover the lower half. Direct a spectrum onto the screen so that half the beam is on the white cardboard and half on the colored sheets of paper. This allows for comparison with the original colors and also shows many combinations all at once.

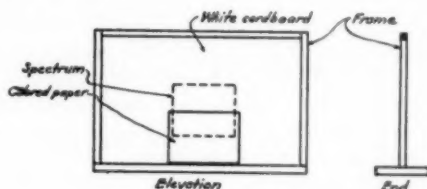


FIGURE 4.—COLOR MIXER

The equipment catalogs are sources of inspiration to the physics instructor who desires to construct certain apparatus. The pictures usually give sufficient detail and a little initiative will help in the matter of materials. Equipment and materials may be obtained occasionally at the local telephone office and repair shop, the radio store, the bicycle shop, and the local university or college physics department. The latter are sometimes surprisingly generous with older or no longer used equipment which would be valuable to the high school. These few places just mentioned may suggest others to the reader.

Besides the joy which comes from creating, the physics instructor and his pupils may get satisfaction from having made a piece of apparatus in a manner similar to the following experience of the writer: The wheatstone bridge had been the subject of study, but was yet somewhat of a mystery.



We set up the water model of the wheat-stone bridge and "put it through its paces." As the demonstration was concluding a pupil spontaneously remarked, "Well NOW I see how it works."

Articles and books on home made equipment other than those already presented follow:

- Glisson, C. O. "Pupil Made Versus Factory Made Apparatus." *School Science and Mathematics* 31:275; February, 1931.
- Harrington, E. R. "How to Increase the Laboratory Equipment." *School Science and Mathematics* 36:39-41; January, 1936.
- Harrington, E. R. "Physics Apparatus and Machine Work Projects at the Albuquerque

High School." *Illustrated Industrial Education* 38:266-67; November, 1936.

- Hyde, G. H. "Home Made Apparatus for the Physics Class." *Science Education* 15:159, 174; March, 1931.
- Lynde, C. J. *Science Experiences with Home Equipment*. Scranton, Pa.: International Textbook Company, 1937.
- Lynde, C. J. *Science Experiences with Inexpensive Equipment*. Scranton, Pa.: International Textbook Company, 1939.
- Monohan, A. C. "Permanent Equipment for High School Sciences." *School Science and Mathematics* 31:51; January, 1931.
- Morrison, C. O. "Laboratory Economies from Junk." *Nebraska Educational Journal* 22:238; May, 1932.
- Overbeck, C. J. "Student Opinion of Laboratory Experiments." *American Physics Teacher* 6:141-42; June, 1938.

## SEMANTICS FOR THE TEACHER OF SCIENCE AND MATHEMATICS

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### DEFINING OUR TERMS

Thinking cannot proceed without language. If our language is slovenly, haphazard, confused, then that is bound to have a distorting effect on our methods of reasoning, our conclusions, our beliefs, our system of values. The semantic discipline aims to do more than serve as a logical detector of errors; it is more than a divining rod of fallacies, a check on linguistic perversions. Formal logic could achieve as much. Semantics has a positive, constructive aspect. It enables us to build our house of values on a foundation of reality; it gives us the courage and the vision to face the world of experience honestly and to form our decisions on the basis of verifiable, empirical knowledge. It makes for sound, dynamic thinking in a pluralistic, multiple-valued universe.

It is curious that those studying semantics for the first time should complain of its obscurity. Such a failure to under-

stand its clear premises testifies to the deep-rooted presence of wrong linguistic and reflective habits; it indicates to what an extent many of us have absorbed the social norms and language fixations of our environment. For this reason, semantics demands a complete reversal of linguistic habits acquired in childhood—habits which have been strengthened and sanctioned by years of usage. It calls for more than a reform of words and their meaning, a stricter adherence to definitions, a more vigilant purity of diction. It points out the necessity for a thorough revision of the theories we hold about mind and matter, man and the world, the individual and society. For the philosophy of life we embrace underlies our manipulation of linguistic forms. In short, semanticists urge us to re-examine our norms of thinking and speech, and then to reject those which, according to semantic standards of sanity, are unsound.

The semanticist is not a revolutionary but an educator. Inward purification must precede any attempt at social reform. Understanding must be achieved before the vision and the will to initiate social change can be effectively mobilized. It is not a matter of acquiring verbal skill, but of nervous reconditioning, of new habit formation. The aim of semantics is not to make professional disputants or embattled skeptics of pupils. The purpose is to secure objective insight, undeceived and uninfluenced by the emotional impact of words.

How can the cardinal principles of semantics be inculcated into the minds of the young? How is education to proceed along new lines? How can the human mind eliminate confusion and achieve sanity?

The consciousness of abstracting can release us from the shackles of linguistic absolutism. What is seen and experienced gives us one level of abstraction; the descriptive process yields another; the act of inference leads us one step higher. This is the procedure we must observe if we are to avoid confusing our orders of abstraction. Only by strenuous and repeated practice can we hope to overcome and root out our unconscious assumptions, our private doctrines, our primitive attitude towards words.

How does a mastery of these semantic principles help people, individually and collectively? The semantic training is intended to protect the young against a multitude of powerful influences that operate internally: influences that are evident in the doctrines we cherish, the values we hold, the language we use. The cure for such disorders is a steady awareness of the various orders of abstraction. Such an awareness enables us to distinguish between the symbol and the thing for which it stands. The awareness, however, is not innate; it is acquired laboriously as the result of education. How then develop a method of properly reacting to the complex

world of stimuli (the "one great blooming, buzzing confusion," as William James described it) that assault our senses? It cannot be gained by rationalization or analysis; the organism-as-a-whole must be affected. A new semantic language must be established to embody these new meanings. To increase our knowledge of nature we must see to it that our new language corresponds to it in structure. The higher and lower centers of the organism must be coordinated to function harmoniously. Man must learn to exercise inhibitory control, and he can do so by utilizing the knowledge and applying the methods of science. Science can save the young from groping blindly in the dark; it permits them to begin where the preceding generation left off.

For those who believe that youth are of romantic illusion all compact, the semantic emphasis on consciousness of abstracting may seem injurious. Such fears are groundless. Children can be taught the consciousness of abstracting, and if they are well taught they will be spared the ordeal of painful adjustment in the future when they will have to find the road for themselves. They will not have to endure the shock and hurt of awakening from their regressive dreams of happiness, their disillusionment at discovering reality to be otherwise than they had imagined it. In his huge volume, *Science and Sanity*, Alfred Korzybski warmly argues that there is no danger of taking the joy out of life by including the study of semantics in the secondary school curriculum. Knowledge and insight increase our potentialities for enjoyment. "With the consciousness of abstracting, the joy of living is considerably increased. We have no more 'frights,' bewilderments, or similar undesirable semantic experiences. We grow up to full adulthood; and when the body is matured for the taking up of life and its responsibilities, we accomplish that, and find joy in it, as our 'mind' and 'emotions' have also matured. Such a consciousness of

abstracting leads to an integrated, semantically balanced and adapted adult personality."<sup>1</sup>

Before administrators will be persuaded of the educative value of semantics, before the schools will include it in their curriculum, before teachers will be convinced of its curative, liberating effect on the mind and emotions of the young, the basic ideas discussed above must be accepted. Wrong semantic reactions are the source of pain and conflict; they use up nervous energy that might be directed to beneficial, integrative ends. The strength consumed in wrestling with devils and shadows and phantoms is released for more constructive and creative purposes. Science must furnish the foundations for a science of man: the outlines and objectives of sanity. The intelligent and efficient application of semantics should result not only in intellectual emancipation but also in a reform of society and the nature of man.

There is much to be gained from uncovering the semantic sources of confusion and perversion in society as a whole. The higher orders of abstraction can and must be controlled, or else they become pathological. The lower orders of abstraction are less dangerous because they are in direct contact with actual experiences, and play an important part in our daily life. Our sense impressions, our feelings, our moods can be checked and regulated, but even these lower centers influence the formation of the higher orders of abstraction, which are at a further remove from the external world. Both the lower and the higher centers are interdependent. For example, thinking and feeling are not separate functions; one profoundly affects the other. Consequently, it may be possible to achieve the desired semantic reform by educating the lower centers. In this way, the great mass of people can be taught how to reason scientifically. For the more advanced students, the language of mathe-

matics will be the path to freedom. Since the nervous system is an abstracting, integrating mechanism, "all human psychoneurological reactions and, particularly, psychological, to be similar in structure, *must* be based on the mathematical theories of statistics and *probability*. On the objective level, we deal with absolute individuals, and so all statements, or higher order abstractions, can only be probable."<sup>2</sup> Primitive in structure, our language attributes separate names to functions and factors, such as body, mind, soul, matter, which cannot be kept apart and which can be studied and talked about only in quantitative terms.

#### THEORY AND PRACTICE

The objections raised against semantics may be summed up as follows: in splitting up spurious abstractions and generalizations, it creates a new army of abstractions, which are challenging but impracticable. It is a brilliant theory but utterly unsuited to the requirements of teaching in the classroom. Tradition and practice are heavily against it. Certainly it has never been fully tried, its advantages have not as yet been conclusively demonstrated.

These objections cannot be lightly dismissed. A theory is validated by its exemplification in practice, by the way it works. The force of these objections, however, is partly spent by newer experimental practices in the field of mathematics. The Thirteenth Yearbook of the National Council of Teachers of Mathematics, *The Nature of Proof*, by Harold P. Fawcett, contains a number of interesting experiments in the teaching of geometry which have implications that extend far beyond the subject of mathematics as traditionally conceived. If the results presented in this volume can be achieved with a group of high school students, there should be no obstacle or opposition to the application of the semantic method to other areas of learning.

<sup>1</sup> Alfred Korzybski, *Science and Sanity* (Lancaster, 1933), pp. 526-27.

<sup>2</sup> *Ibid.*, p. 310.

After taking a course in demonstrative geometry which emphasized clear and exact thinking, students became more logical and more critical in their attitude. Geometric proof was employed, not as a mnemonic device, but as an aid to the cultivation of critical thinking. What makes this book specially significant is the evidence it brings forth to show that the power of thinking clearly in geometry situations does lead to the power to think with equal clarity in situations outside of geometry. There is a transfer of learning. Habits of rigorous thinking can be developed in students: habits of analysis, of suspended judgment, of defining all relevant and pivotal terms. The fruit of this novel course in demonstrative geometry was the realization of the significance of undefined concepts in arriving at any conclusion; the recognition of the importance of sharply defined terms and their central role in determining the nature of the conclusion; the perception that a number of assumptions which are unproven are still necessary. The test of understanding the nature of proof should be the ability of pupils to apply it consistently and successfully to problems that arise in the course of daily life. It should manifest itself in their behavior, in their demand that evidence be presented, and in their cautious analysis of the validity of the evidence, in their evaluation of the assumptions used in supporting a conclusion.

But the semantic discipline stresses not only the logical but also the psychological function of thinking. Even in this respect, the new method of teaching geometry proved fruitful. Students were challenged to examine concepts like "one-hundred per cent Americanism," "the labor class," "obscene books," an "aristocrat." While they were able to discuss mathematical concepts calmly, emotional heat was soon generated when they attempted to define "labor class" and "aristocrat."

It is not through the study of mathematics alone that the power of discrimi-

nating thinking will be developed; the semantic method must also be applied to those fields of study in which language and expression play an important part. For example, what was tried in the geometry class could also be tried on a more systematic and elaborate scale in history and science classes: the geometry students analyzed advertisements, the statements of which were put to the test of proof. Once the assumptions on which the advertisement rested, were defined, it ceased to exercise its strong appeal. What is even more significant, exercises were assigned in which the pupils were asked to state the facts and the assumptions which supported beliefs like "racial superiority," "a citizen's obligation to his government in time of war," and so on.

This is one instance of a successfully conducted experiment in semantics. It indicated that semantic analysis is not beyond the intellectual powers of the pupils. If anything, it awakened their interest; these lessons were meaningful and alive. Nothing is more puzzling and distressing to the young than the interpretations of life they hear about them. They have absorbed a hoard of maxims, proverbs, folk sayings, popular phrases and slogans and stereotypes, which summarize the experiences and conclusions of many people. They are inclined to repeat them, to take them trustingly on faith, but it is doubtful if they grasp their full import or are tempted to question them closely. Their range of personal experience is, after all, limited. Inadequate as it is, however, they are painfully conscious of the contradictions that exist between precept and practice, theory and conduct. But if the chief aim of science is to train pupils to apply the scientific method to all the problems that come up in or outside the classroom, then the critical spirit is as essential in the teaching of social studies or geometry or economics as it is in teaching of physics or chemistry. That critical spirit can function freely when it is disencum-

bered of the dead weight of tradition, when it learns to weigh evidence, to discriminate between language that is emotional and language that is denotative and precise.

Science has in part already succeeded in creating a new morality, a new set of ideals and attitudes, new ways of envisaging the world and human nature. It has been responsible for bringing new desires and new ends into being. Once we grant that science is not remote from the struggle of living, from the vital issues which affect men, we then see it in a new light. We see that it must take into account the desires, instincts, emotional attitudes and wants of men in society. It must discount the older theory that the dominant incentives to action are intellectual, that ideas are the foundation of conduct. Science must take cognizance of moral values. Desires must be recognized as a given datum, and proper methods for controlling and directing them must be devised. Men must decide what kind of government they want, what kind of associations they wish to establish. Scientific attitudes must become ingrained, as it were, in the constitution of human beings and used for the betterment of life in all its rich variety.

The study of semantics, it is obvious, is concerned with no specific subject matter; it includes practically every branch of human knowledge. From every science it appropriates the essential elements and incorporates them in a functional synthesis that will aid in the understanding of the world: an understanding that will manifest itself in a more efficient working of the organism and a more efficient control of the physical and social environment. In its concrete applications, the science of semantics analyzes the nature and use of symbols, its aim being to purify linguistic usage and make it correspond with empirical reality. The semanticist begins with people, with the processes that go on in their minds and bodies. Once the people are semantically emancipated, once they are trained in the use of a multiple-valued language, they will be skeptical not only of abstractions but also of propagandistic lures, political oratory, economic humbug. Institutions and laws are made by men. Human beings can shape their social destiny. But it will take a mighty long time before a scientific concept of society will establish itself.



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# Abstracts

## GENERAL EDUCATION

**SYMPOSIUM.** "Education for the Gifted." *Teachers College Record* 42:375-460; February, 1941.

This symposium includes the following articles: (1) "The Importance of Social Capillarity" by William F. Russell, (2) "The Place of the Gifted in Industry and Business" by Lammont du Pont, (3) "The Place of the Gifted in Modern Life from the Viewpoint of Labor" by Spencer Miller, Jr., (4) "Education's Role in Development" by Robert L. Thorndike, (5) "Superior Ability" by Rudolf Pintner, (6) "Gifted Children in Small Cities" by Edward L. Thorndike, (7) "Administrative Problems in the Education of the Gifted" by David E. Wegelin, and (8) "Some Issues and Problems Raised in the Seminars." —C.M.P.

**HAYES, WILLIAM C.** "Daily Life in Ancient Egypt." *The National Geographic Magazine* 80:419-515; October, 1941.

This unusually fine treatise on the life of the ancient Egyptians portrays them as the very ordinary men and women they were—simple, hardworking, cheerful, thoroughly human. The 32 paintings by H. M. Herget on the life, culture, and history of the Egyptians, greatly adds to the interest and attractiveness of the article. —C.M.P.

**GREGG, RUSSELL T.** "Professional Graduate Education for Secondary Schools." *School and Society* 53:745-750; June 14, 1941.

Modern schools demand that teachers have the following competences: (1) "an understanding of the true purposes of secondary education in present-day America," (2) "thorough acquaintance with the nature and problems of adolescent growth and development and their implications for the secondary-school program," (3) "ability to participate and contribute in the development of the philosophy and policies of the school, in the building of an appropriate curriculum in promoting school and community projects, and in evaluating the efficacy of the educational program," (4) "a willingness to study the community and its agencies and to cooperate with them in order to provide for the most effective educational program possible for the youth of the community." The author advocates the workshop approach for professional graduate courses. The following are advantages of the workshop approach: (1) greater flexibility, (2) more emphasis on individualized procedures, (3) increased student-participation, (4) better

cooperative relationships among staff members, and (5) more comprehensive evaluation procedures. —C.M.P.

**BIGELOW, BRUCE M.** "Jottings from a Traveller's Scrapbook." *School and Society* 54:293-297; October 11, 1941.

American colleges have many similar problems and a multifarious array of students. Attitudes toward admission, school records, freshman scholarships, and publicity have changed, and on the whole, for the better. The curriculum lends itself to both censure and praise and will always be in a state of change. Senior colleges may believe they are experimenting, but their adventurous spirit lags far behind that of the junior college. Integration generalizing experiences, on-going processes, real individualism, university amputation, and college decapitation are chiefly empty descriptions. When colleges and universities stop their fretting about curricula and devise methods of attracting better teachers, then, and only then, will we see a great day coming in higher learning. —C.M.P.

**JOHNSON, GEORGE R.** "Freedom to Teach: The Way to Realize New Purposes in Education." *School and Society* 54:17-19; July 12, 1941.

"Freedom to teach includes freedom from activities prescribed in a curriculum, freedom from an arbitrary list of essentials, minimum or otherwise, freedom from grade norms or standards of attainment, freedom as great as any physician has when he is treating an injured patient. Freedom to teach requires freedom from dictation. The supervision of classroom teaching by subject or grade specialists is archaic. Education suffers today from too many supervisors, too many directors, too many superintendents, too many bosses. Their existence almost invariably operates to formalize education, standardize procedure, regiment the staff and produce mechanical rather than creative teaching. This happens primarily because high-salaried people at the central office must do something to justify their jobs." —C.M.P.

**ANONYMOUS.** "Salaries of City School Employees." *National Education Association Research Bulletin* 19:67-95; March, 1941.

This report covers the school year 1940-41, and includes 1949 cities. As compared with 1938-39, the trend has been upward in all types of positions. In most cases salaries exceed those of 1930-31. —C.M.P.

SYMPOSIUM. "Workshops." *Educational Research Bulletin*. 20:115-143; May 14, 1941.

Four articles have been contributed to this *Bulletin* as follows: (1) "The Workshop" by Louis Rath, (2) "Workshops in Secondary Education" by Alan Griffin, (3) "Workshops in Elementary Education" by Laura Zirbes, and (4) "The Workshop in Teacher Education" by E. J. Ashbaugh.

—C.M.P.

KENT, GEORGE. "Mill Town Miracle." *School and Society* 54:81-85. August 9, 1941.

This article describes the remarkable transformation in fourteen mill towns surrounding Greenville, South Carolina (the Parker district) under the guidance of Superintendent of Schools, L. P. Hollis.

—C.M.P.

FOX, JAMES HAROLD. "Newer Instructional Practices." *School and Society* 54:49-52; July 26, 1941.

The writer develops the thesis that many of the newer instructional practices are not as promising as they appear to be. Too often attention has been and is called to the successes, and the failures ignored.

—C.M.P.

SYMPOSIUM. "A Handbook for Student Teachers and the Supervisory Staff." *University High School Journal* 19:113-176; April, 1941.

This is the third revision of an excellent handbook, useful for the student teacher, critic teacher, and the supervisor. The three major phases of this handbook are: (1) "The Student Teachers at Work," (2) "After Supervised Teaching," and (3) "Supervision of the Student Teacher."

—C.M.P.

COLLINS, NORA. "Dare Teachers Be Citizens?" *The Clearing House* 15:323-326; February, 1941.

If, by citizens, is meant the right to take part in elections as other citizens do, the answer is definitely *no*. If you want to hold your job and not be deliberately annoyed and penalized, demoted, or fired—keep mum about elections and voting.

—C.M.P.

LANGE, PAULUS. "Some Issues in General Education." *The Phi Delta Kappa* 23:315-319; May, 1941.

Some of the issues discussed in this article are: (1) need of defining the term general education, (2) who should take general education? (3) are general educational courses terminal or foundational? (4) status of general education faculties, (5) kind of subject matter,

(6) approach to or treatment of subject matter, (7) relative importance of method and content, and (8) evaluation.

—C.M.P.

SYMPOSIUM. "Education for National Defense." *Teachers College Record* 42:283-339; January, 1941.

Problems of national defense as they relate to education are discussed in this issue. Articles and authors are as follows: (1) "The American Way of Life" by Thomas H. Briggs, (2) "Education, Citizenship, and Character" by Lyman Bryson, (3) "Education for Vocational Efficiency" by Hamden L. Forkner, (4) "Health and Physical Fitness" by Clifford Lee Brownell, (5) "The American Way of Life and Educational Opportunity" by George D. Strayer, and (6) "In These Bad Days" by Allan Abbott.

—C.M.P.

LORGE, IRVING. "Evaluation: The New Stress on Measurement." *Teachers College Record* 42:667-679; May, 1941.

Schoolmen are in rebellion toward the word measurement but not against the process measurement. Most schoolmen desire to appraise or evaluate the consequence of their efforts. Evaluation involves more than mere measurement, although it does include that. Evaluation is a complex and difficult process and there are several kinds of evaluation. The evaluation of "newer" and "older" practices may become a battle of values.

—C.M.P.

FEATHERSTONE, W. B. "How Should the Curriculum Be Planned?" *Teachers College Record* 42:577-590; April, 1941.

This article discusses four ways in which the curriculum can be planned, who would plan the curriculum, areas of common enterprise, and designing the curriculum. Several reasons are advanced to show that basing the curriculum on the personal problems of pupils is inadequate. Curriculum making should be a cooperative enterprise.

—C.M.P.

TELLER, JAMES D. "Are American Schools Democratic?" *School and Society* 53:684-688; May 31, 1941.

According to the author "democracy is perhaps the most discussed and the least practiced way of life in the teacher-training institutions of the country." George S. Counts points out that democracy is more than a form of government: "It is an attitude of mind—a way of life—an order of social relationships—a society in which ordinary men and women may grow to their full stature—a society of the people, by the people, for the people." Max Otto emphasizes that democracy is not rugged individualism. Two basic assumptions of democracy are: "One postulate concerns individual growth and the

other considers social action, we must provide the essentials of a method for assuring intelligent consent by the people. This method of giving intelligent consent is conditioned by at least four requisites. In the first place, it requires certain guarantees of the civil and political liberties of all the people; that is, it demands a popular charter of rights. In the second place, universal machinery must be set up so that each man can register his decision—*popular suffrage*. In the third place, schools must teach the methods that man has evolved for collecting data essential to the solution of problems and for organizing these data—*popular literacy*. In the fourth place, the method of giving intelligent consent necessitates the cultivation of the discrimination and judgment of the masses of people; that is, it requires *popular understanding* of their collective affairs."

—C.M.P.

KNIGHT, EDGAR W. "Getting Ahead by Degrees." *School and Society* 53:521-528; April 26, 1941.

Americans seem to have a mania for degrees. Hence the "conferring" of degrees has been a rich field for some pseudo educational colleges. A ten dollar fee has been the necessary requirement to obtain a doctor's dissertation if one were so extravagantly inclined. For a long time the Master of Arts was conferred as an honorary degree. According to the official historian of Harvard, the class of 1869 was the last at that institution "whose members were allowed to take the M. A. for keeping out of jail five years and paying five dollars, as the saying goes." The conferring of the Ph.D. as an honorary degree continued shamelessly for a long time—even as late as 1912. The first Ph.D. awarded at Teachers College was in 1899. The first earned Ed.D. was awarded by Harvard University in 1920. In 1936 the higher educational institutions of this country "awarded 163 different kinds of degrees in course, creating 143,000 bachelors, 18,000 masters, and 2700 doctor's. As frosting for the cake, honorary degrees of 51 varieties were awarded to 1350 persons."

—C.M.P.

THORNDIKE, ROBERT L. "Bugs' in Dissertations." *The Advanced School Digest* 6:116-118; May-June, 1941.

Recurring shortcomings encountered in dissertations are a lack of clarity, conciseness and attractive style; a failure to make the summary stand alone, complete in miniature. Making findings and interpretations clearly distinguished and segregated; improper handling of tables; failure to exclude extraneous materials, including unnecessary references; and failure to write simply, are other "bugs."

—C.M.P.

JOHNSON, F. ERNEST. "The Comprehensive Examinations." *The Advanced School Digest* 6:80-82; March, 1941.

This article is concerned with the philosophies underlying, and practices in, giving comprehensive examinations for the degree of Doctor of Education at Teachers College, Columbia University. A new plan of giving the comprehensive examinations was tried out during the past year. In this plan the oral examination precedes the written and the plan calls for much more active participation on the part of the candidate.

—C.M.P.

LINTON, CLARENCE. "Advisement of Candidates for Doctor's Degrees in Teachers College." *The Advanced School Digest* 6:49-54; January-February, 1941.

Under the general topic of basic assumptions underlying the program of professional advisement are discussed: (1) "Responsibilities Assumed by the College," (2) "Responsibilities Assumed by the Student," and (3) "Shared Responsibilities of the College and the Student." Four phases discussed under the general topic "Special Problems of Advanced Level Graduate Students": (1) "In what area or field should the student specialize?" (2) "Is the Doctor's degree necessary or advisable in the area or field chosen by the student?" (3) "Should a given student attempt to qualify for a doctorate?" and (4) "What are the chances of placement of persons holding a doctor's degree in a given area or field of specialization?"

—C.M.P.

BAHM, ARCHIE J. "What Is Philosophy?" *The Scientific Monthly*. 52:553-560; June, 1941.

Philosophy is a kind of attitude, a kind of method, a group of problems, and a group of theories. The author discusses and describes each of these four components at some length. In addition he discusses the various domains of philosophy.

—C.M.P.

SUTTON, WILLIS A. "Education the Mainstay of Business." *The Journal of the National Education Association of the United States* 30:130-134; May, 1941.

This is an unusually fine statement that vividly shows that American business definitely receives large returns for the money that is now being spent on education. Education is the basis of real, genuine, production of wealth. The cultural level of the masses is the bases of good government. Poverty doesn't make anybody any money.

—C.M.P.

## SCIENCE EDUCATION

CARLSON, A. J. "Is This An Age of Science?" *Science Digest* 9:61-67; April, 1941.

This article is condensed from Sigma Xi Quarterly. Although many writers call this the Age of Science, the author answers the question negatively. We as yet do not use the scientific method in solving our problems or in the attitudes taken toward various aspects of life. Modern science does not measurably influence human drives and conduct individually, nationally, or internationally.

—C.M.P.

WILSON, SHERMAN R. "Science Fusion and Mental Confusion." *The Science Teacher* 8:24-25; 32-33; February, 1941

The author agrees that high school science needs improving both in method, and in kind of content, but he seriously questions that fusion or integration is the way out. Fused science courses are more likely to lead to mental confusion and quotes Knox in support of his contention. In Detroit such a program as the author believes is best, is being worked out in separate courses in physics and chemistry. The courses might be described as "workshops in science" and the work is made as practical as possible.

—C.M.P.

MILLER, D. F. "A Summary of Part of the Questionnaire Sent to Teachers of Biological Sciences in Secondary Schools." *The American Biology Teacher* 3:221-227; April, 1941.

Findings in this report are based on replies obtained from 3186 biology teachers. About two-thirds of all biology teachers are men. The subject most frequently taught with biology is general science. The biology teachers report that about one-fourth of the content of the general science course they teach is biological science. Nearly three-fourths of the biology teachers prefer to teach the biological science they are now teaching. The average number of Teachers Associations, Scientific Societies, and Educational Organizations memberships held by biology teachers is slightly less than two.

—C.M.P.

SYMPOSIUM. "The Physical Sciences." *Teacher Education* 4:3-26; March, 1941.

This bulletin of the Illinois State Normal University includes the following articles: (1) "The Education of the High School Physical Science Teacher" by Howard W. Adams; (2) "Visual Education for Science Teachers" by C. L. Cross; (3) "Consumer Science in the Secondary School" by Ralph W. Fogler; (4) "The Cost of Equipping the Small High School for Chemistry" by R. U. Gooding (5) "Why

Teach Photography?" by Howard J. Ivens; and (6) "Functional Physical Science" by L. S. Smith.

JAMES F. CYRIL. "Science and Society." *The Scientific Monthly* 53:51-60; July, 1941.

The article advances the thesis that the impact of science on society has not been wholly beneficial. Western society faces a major task in deciding upon what its ideals are. The forces that science has placed at our disposal are already sufficient to make the attainment of these ideals a practical possibility.

—C.M.P.

BLACKWELDER, ELIOT. "Science and Human Prospects." *Science* 93:359-366; April 18, 1941.

The author develops the thesis that the basic thing about science is an attitude or habit mind, a way of thinking. The major objective of science is truth. The scientific method is new, and progress has been slow. The methods of science are needed in solving the varied problems of society.

—C.M.P.

BURNETT, R. WILL. "Opinions of Science Teachers and Their Implications for Teacher Education." *Teachers College Record* 42:709-719; May, 1941.

This article presents a summary of some results of a national survey of science teachers' opinions on certain professional and social issues. A total of 8589 copies of two forms of a questionnaire was distributed with usable returns received from 2309 or 26.9 per cent. Evidence points to this return being a truly random sample. Science teachers consider one of their major functions to face the problems and interests of young people and society, and to bring on these problems and interests. More than 80 per cent of all science teachers (elementary, junior high, and senior high) stated the belief that an important function of science education is to deal with present unsolved problems, and to offer the best scientific evidence available on these problems. There is an indication that science teachers avoid teaching areas that they accept as important. There is definite evidence that the preparation of science teachers is inadequate. Some implications of the findings of this study are included.

—C.M.P.

FAWLEY, GLADYS. "The Social Value in Developing Readjustment Thinking in Geography." *The Journal of Geography* 40:192-196; May, 1941.

Geography should develop in students a feeling of personal responsibility toward community,



state, regional, and national problems. The article describes the attempt being made at Florida State College for Women to make the above aim more functional.

—C.M.P.

MCLEAN, FRANKLIN C. "The Happy Accident." *The Scientific Monthly* 53:61-70; July, 1941.

The conception that discoveries and inventions are or have been lucky accidents has been grossly exaggerated. A few such have occurred but as a rule, discoveries and inventions have involved much careful, tedious research and thinking.

—C.M.P.

CARTER, VERNON. "Chemurgy and Conservation." *The Journal of the National Education Association of the United States* 30:69-70; March, 1941.

Chemists and conservationists need to work hand in hand if the best results are to be had in the attempts at conservation of soil, water, forests, wildlife and minerals. Only through this cooperation will result increased incomes, higher property values, more tax income, better public services, and a higher standard of living.

—C.M.P.

BRODSHAUG, MELVIN, AND HAGGERTY, HELEN. *Control of Body Temperature and The Work of the Kidneys*. Chicago: The University of Chicago Press, 1941. 32 p. each. \$0.15 each.

These guides are to be used by instructors before using the two new sound films of Erpi's Human Biology Series. Each guide gives the narrative of the film, and describes the scenes of the film. An annotated bibliography and copious notes on the subject are helpful to one wishing to teach by the use of these films.

—Roy V. Maneval.

ANONYMOUS. "Science for Defense." *Science News Letter* 40:154-155; September 15, 1941.

This article contains excerpts from an address by Watson Davis, Director of Science Service, before the Department of Science Instruction of the National Education Association at its Boston meeting last July. Among points stressed are the place of science in national defense, and the need for new ideas. Several recent important developments in science were referred to, as well as some of the opportunities of teachers.

—C.M.P.

RINEHART, JOHN S. "Student Likes and Dislikes in the Elementary Laboratory." *American Journal of Physics* 9:218-220; August, 1941.

This is the report of a questionnaire study of 150 students in elementary physics laboratory at the State University of Iowa. Student opinion as to what experiments they liked and disliked was obtained. Students prefer practical experiments, capable of yielding good results that can be verified. Instructions for experiments should be as clear and concise as possible, and still not hamper the students too much.

—C.M.P.

MILLIKAN, ROBERT A. "The Opportunity of the Physics Teacher." *American Journal of Physics* 9:81-84; April, 1941.

Physics is admittedly the best subject in the whole curriculum for testing the analytical aptitudes and capacities of the student, that is, in finding out whether he is likely to make a success of any of the analytical pursuits such as all the sciences, law, medicine, engineering, finance, management, government, and so forth. The most important job of the teacher is to know his students, every one of them, so that he will make as few mistakes as possible in rating their qualities and their capacities justly and accurately in order that he may steer them wisely. Talking entertainingly to a hundred or two hundred students is a wholly subordinate and trivial requirement of a good teacher. The great, indispensable requisite is conscientiousness in watching carefully and discriminatingly the way his students solve problems, the way they do their laboratory work, the way they answer examination questions, the way they pose questions of their own.

—C.M.P.

HOPKINS, B. S. "The Expanding Horizon of Inorganic Chemistry." *Science* 93:553-557; June 13, 1941.

The author states: "It is doubtful if the history of science has ever experienced a broader and more general advancement in an equal period of time than the world has witnessed during the years 1921-1941. Developments in all phases of science have been startling in their scope." The thesis of this article is the very rapid advances being made in inorganic chemistry. Many instances are cited.

—C.M.P.



# Book Reviews

## SCIENCE TEXTBOOKS, WORKBOOKS AND TEACHERS' AIDS

ARTHUR, PAUL. "Lecture Demonstrations in General Chemistry." New York: McGraw-Hill Book Company, 1939. 455 p. \$4.00.

Chemistry instructors in college and high school will find here a most useful series of lecture demonstrations with complete directions. More than 1000 experiments are grouped under 175 topical headings. Directions include quantities of reagents, size and type of apparatus, and the method of handling the experiment in class to make it most readily visible to large groups. Diagrams showing experiment set-up accompany numerous experiments. Few, if any, experiments are omitted from those that might normally be demonstrated in any college or high school chemistry class.

The author, at present in charge of lecture demonstration work at Oklahoma Agricultural and Mechanical College, formerly had charge of the same work for three years at Washington Square College of New York University.

—C.M.P.

VANCE, B. B., BARKER, C. A., MILLER, D. F. *Biology Workbook*. New York: J. B. Lipincott Company, 1941. 316 p. \$0.92.

*Biology Workbook* is organized into thirteen units beginning with "Our Allies and Enemies—the Insects." The usual units of biology are all there, but they have been re-worded to focus attention upon the practical which a knowledge of biology brings. There is a fine unit on our own bodies, another on heredity; and units twelve and thirteen, dealing with "Man the Waster" and "Biology for Pleasure and Profit," are a welcome addition to classroom procedure. The list of projects closing the book ought to prove valuable because they are the basis of much class activity. Teachers will welcome a text which pays so much attention to what is common in our environment and the method provided by this workbook for the study of them.

The authors are experienced teachers of high school biology and know the importance of developing biological skills and attitudes in young people. The book is profusely illustrated, and students will learn much from just a study of these illustrations. The book combines a wealth of material—63 unit problems, 57 assignments, 125 optional activities, 13 review tests, 35 experiments, and 7 demonstrations.

—Greta Oppe.

STEWART, OSCAR M., AND CUSHING, BURTON L. *Physics for Secondary Schools*. Boston: Ginn and Company, 1941. 760 p. \$1.80.

This secondary text offers a thorough course in physics for high school boys and girls who need to meet college entrance requirements. However, by assigning more or less of the starred material, a teacher may adapt the text to the capacities of pupils of varying degrees of ability. It is written in a true scientific spirit, but a great deal of care has been taken to simplify the technical and to motivate the factual material to make it also practical. It is replete with illustrations and adequate descriptive and explanatory text.

There are thirty chapters dealing with the usual units of physics. A pleasing and helpful innovation is the interesting discussion before each of these units which not only opens a unit but relates it to the content of each of the other five. This will help students to get a continuous picture of physics and physical principles in their proper relationship. Each unit contains questions, problems, and topics for further discussion or investigation.

—Greta Oppe.

SKILLING, WILLIAM T. *Tours Through the World of Science*. New York: McGraw-Hill Book Company, 1941. 815 p. \$1.70.

Instructors of general science will be interested in this revision of a book with which they may be already familiar.

The organization of this book is unique. It is divided into nineteen tours. Each tour has a section called "Where the path will lead." This is followed by "Preparation for the trip." At the close of each tour is a section called "Telling others what you have seen." A list of questions is found at the end of each tour.

Many changes have been made in the revised edition to make it up-to-date. Tours of Air and Weather, Chemistry of Common Things, Electricity in Modern Daily Life, Communication by Wire and Radio, and Light and Eyesight show many improvements.

This book is well illustrated. It can be used profitably by general science classes either as a text or as supplementary material.

—Roy V. Maneval.

RITCHIE, JOHN W. *Biology and Human Affairs*.  
Yonkers, N. Y.: World Book Company, 1941.  
983 p.

The preface of this high school text makes a helpful analysis of the methods of biology teaching into three types and states that this book follows a balanced middle course attempting to bring out the advantages of each of the three methods. Much enriching material is included in the text to meet the need of those high schools with weak libraries. Special individual and group projects are suggested and the organization is flexible. The emphasis is on the place of the human being in the biological world. The text is excellently illustrated. Each of the 22 "Units" is made up of from four to eight "Problems." Each unit is accompanied by a unit comprehension test which is not of the objective type and a list of excellent suggested activities and applications. In the appendix is a brief classification scheme of plants and animals excellently illustrated with line drawings of common types, a chart of the divisions of geological time, and a glossary.

—O. E. Underhill.

STANFORD, E. E. *Man and the Living World*.  
New York: The Macmillan Company, 1940.  
916 p. \$3.50.

This volume has extensive coverage of the biological survey field for a college course. It is, perhaps, more comprehensive than the average college course, but for shorter courses it is always possible to eliminate material by selection. A strong feature of the book is the emphasis given to the human body, to human needs, and to human interests. The contents: *Unit 1*, Science and Living Things; *Unit 2*, The Green Plant, Manufacturer of Foodstuffs; *Unit 3*, The Human Body; *Unit 4*, The Maintenance of Health; *Unit 5*, Microorganisms; *Unit 6*, A Survey of Animal Life; *Unit 7*, A Survey of the Plant Kingdom; *Unit 8*, Evolution and Heredity; *Unit 9*, Domestication and Breeding of Plants and Animals; *Unit 10*, The Biological Resources of the United States and Their Utilization. There are 451 illustrations. The appendix gives a bibliography for further reading.

—W.G.W.

HENDREN, LINVILLE L. *A Survey of Physical Science, Part I and A Survey of Elementary Physics*. Athens, Ga.: The University of Georgia Press, 1939. 556 p. 392 p. \$3.25; \$2.25.

Dr. Hendren has published two books, with the Physics Survey constituting the first three hundred ninety pages of the Physical Science Survey. These texts are the syllabi used in the General Physical Science Courses at the University of Georgia and in the University System in Georgia. Part II of the series will be the geology and chemistry sections. Except

for the addition of plates and drawings these texts are still syllabi. They are exceedingly well done in that they contain concise statements of the fundamental principles and laws of physics and astronomy but they are not texts. Students require a limited amount of explanation in order to acquire the abilities usually given as objectives of a general course. The author of the text, evidently quite aware of this, included an extensive list of references at the end of each chapter. The beginning of each chapter is a statement of some famous person, apropos the subject matter of the text. Some examples are quite interesting, for example the chapter on "Color and Spectra" has William Cullen Bryant's statement—"To him who in love of nature holds communion with visible forms, she speaks a various language." One that any physics teacher will appreciate heads the chapter on accelerated motion—Sir Humphrey Davy—"One use of physical science is that it gives definite ideas." No doubt, Dr. Hendren has had the difficulty of teaching beginners the distinction between velocity and Acceleration. Emerson's statement "All wish to know but few the price will pay" is applicable to many.

Another noteworthy addition for those teachers who use Erpi Classroom Film is that plates made from the film are included as illustrative material. This is an aid in integrating the text with the film.

—Herman Roth.

DAVIES, EARL C. H. *Fundamentals of Physical Chemistry*. Philadelphia: The Blakiston Company, 1940. 447 p. \$3.50.

This is an excellent survey of the field of physical chemistry from the most modern viewpoint for those students who do not need a detailed, comprehensive knowledge of the subject. It is very readable, sufficiently elementary, has fine diagrammatic illustrations as well as a number of photographs and noted people in the field. Many suggested demonstrations and useful exercises are included.

—Ruth Gerber.

CHIRONIS, NICHOLAS D. *Organic Chemistry*.  
New York: Thomas Y. Crowell Company,  
1941. 728 p. \$4.00.

The author of this book, who is connected with the Chicago City Colleges, has produced an organic chemistry somewhat different in organization from the usual text. The first four chapters are used for orientation and overview. The hydrocarbons and the simple groups of organic compounds are then studied as a whole without the usual separation into aliphatic and aromatic. The study of benzene is introduced early in connection with the study of the cyclic unsaturated hydrocarbons. The complex benzenoid compounds are given in the latter part of the book. Two chapters are used for the discussion of the theories of organic chemistry.

At the end of each chapter is a list of problems and exercises.

This text is up-to-date and well written. It is the result not only of theory but also of a great amount of practical experience by the author. It is designed for flexible use and need not be followed rigidly as to sequence. Chemistry instructors should examine it.

—Roy V. Maneval.

ELDER, ALBERT L. *Textbook of Chemistry*. New York: Harper and Brothers, 1941. 751 p. \$3.75.

Here is a new college text that is designed primarily for the student who plans to make a branch of science his life work. It will provide a thorough course in the subject.

The author discusses atomic structure in the first seven chapters. The following eleven chapters are devoted to the concepts of physical chemistry. With this background, each topic in the next twenty-one chapters is considered fully when introduced. The chapter on organic chemistry, which is the last in the book, may be omitted if the instructor wishes.

This text is well illustrated. Many commercial photographs are used. A number of pertinent problems are listed for each chapter. A laboratory manual by the author is also available. College instructors of first year chemistry should examine this new text.

—Roy V. Maneval.

ELDER, ALBERT L. *Laboratory Manual for General Chemistry*. New York: Harper and Brothers, 1941. 259 p. \$2.00.

This manual contains, besides the usual typical chemistry experiments, suggestions for experiments devised by pupils. Many of the experiments are built up in such a way as to focus attention upon relationships and ideas rather than mere cookbook observation. Thought questions suggest leads which must be followed by reading. Care has been taken to formulate questions which avoid suggesting the answer. An attempt has been made to obtain the advantages of the blank-filling type of reporting, and, at the same time, to avoid a cookbook type of manual. The experiments are well designed to bring out the fundamental principles of chemistry. It is a manual on the college level.

—O. E. Underhill.

BEAUCHAMP, WILBUR L., MAYFIELD, JOHN C., AND WEST, JOE Y. *A Study-Book for Science Problems 3*. Chicago: Scott, Foresman and Company, 1941. 316 p. \$0.76.

This is a study-work-book adapted to use with text by the same authors. It has outlined directions and questions with blank spaces for pupil answers. It is so graded with first, second and third degree difficulty work that it can take care of individual differences in ability of pupils.

—W.G.W.

WEYMOUTH, CLINTON G. *Science of Living Things*. New York: Henry Holt and Company, 1941. 534 p. \$1.84.

This book is written to help the everyday citizen and student of science to solve the biological problems that he meets in daily life. It stresses biological principles and useful information. The 12 units include: the home; origin and composition of living things; plant groups; invertebrates and higher animals; living food factories; friend and foe insects; food and living organisms; plant and animal behavior; the human body in health and disease; conservation; and changes wrought by nature and man. Each unit ends with a list of "Activities" and at the end of the book there is a helpful bibliography and a glossary. The book is well illustrated with halftones.

—W.G.W.

BENEDICT, RALPH C., KNOX, WARREN G., AND STONE, GEORGE K. *Life Science*. New York: The Macmillan Company, 1941. 682 p. \$2.00.

*Life Science* is not "just another biology." Every chapter has the spark to kindle a desire to read it through. Useful facts about common processes useful to man hold the interest. Simple straight-forward language with a minimum of technical terms favor quick understanding. It includes the usual material for a first course in biology in high school. It emphasizes relations to other sciences as well as the social implications of biology. We think you will like this text.

—W.G.W.

BLACK, NEWTON HENRY. *An Introductory Course in College Physics*. New York: The Macmillan Company, 1941. 734 p. \$3.75.

This book is a complete revision of the author's *College Physics* with new sets of problems and many new figures. It is an excellent textbook of general physics which treats the subjects of mechanics, heat, magnetism and electricity, sound, and light in the order named. It contains 37 chapters, numerous appropriate figures, a subject index, 12 pages of data in an appendix, and useful references at the end of most of the chapters. The author and some of his colleagues have used the book for five years at Harvard University with students who were beginning the subject in college. It is designed for pre-medical students, prospective engineers, and for students desiring a knowledge of general physics as a part of a liberal education. The emphasis given to the important points by means of heavy type, the carefully selected problems and figures, and the summary at the end of each chapter contribute much to its value as a textbook. It should serve also as a splendid reference book in general physics.

—H. A. Miley.

LATON, ANITA D., AND BAILEY, EDNA W. *Suggestions for Teaching Selected Material from the Field of Sex Responsiveness, Mating and Reproduction*. Bureau of Publications, Teachers College, Columbia University, 1940. 113 p. \$1.35.

Every teacher in high school biology should read this monograph, the second of a series put out by the Bureau of Educational Research in Science. The suggestions given in the introduction as to how the teacher may gain experience enabling her particularly to understand the nature of the problems of sex education are excellent. The general plan of the monograph is well stated in the foreword as follows: "This monograph begins with a description of the background of mingled knowledge, ignorance, and misconceptions which a teacher may expect to find in students of different ages and from varying socio-economic and cultural groups. There follows a survey of the possible ways in which instruction in this field may influence the knowledge, feeling and conduct of students." Specific examples are given of ways in which the problem has been approached in different schools. A selected annotated bibliography is given.

—O. E. Underhill.

NEW JERSEY STATE TEACHERS COLLEGE, MONTCLAIR, N. J., VISUAL AIDS SERVICE. *Visual Aids in the Realm of Biology*. 1941. 21 p. \$0.50. *Visual and Teaching Aids in Safety Education*. 1941. 6 p. \$0.15.

These sets of mimeographed sheets give a list of distributors of films, filmstrips, slides, pictures, charts, exhibits, and pamphlets. Some materials are free. There is a useful index to various topics.

—W.G.W.

REED, RUFUS D., Compiler. *Visual Aids in the Realm of Chemistry*. Montclair, New Jersey: New Jersey State Teachers College, 1940. 11 p. \$0.25.

This compilation of visual aids, useful in the teaching of junior high school science and senior high school and college chemistry, has been compiled by Dr. Reed from material collected in connection with the Visual Aids Service of the Montclair State Teachers College. Charts, exhibits, films, pictures, slides, and pamphlets are listed under the various topics which would be discussed in a chemistry course. School librarians in the State of New Jersey may obtain one copy free upon application. Anyone wishing to obtain this list should address Visual Aids Service, New Jersey State Teachers College, Upper Montclair, New Jersey, and send twenty-five cents but not in stamps.

—O. E. Underhill.

PIERCE, WILLIS CONWAY, AND HAENSCH, EDWARD LAUTH. *Quantitative Analysis*. New York: John Wiley and Sons, Inc., 1940. 462 p. \$3.00.

The material is so arranged and of such scope that the book makes a good text for either a one-semester or two-semester introductory course in analytical chemistry. A wide range of laboratory exercises is included. In addition to an elementary presentation of analytical principles and practices, chapters are devoted to an advanced treatment of theory, specialized methods of analyses, as well as the use of chemical literature.

—Ruth Gerber.

BEAUCHAMP, WILBUR, AND MAYFIELD, JOHN C. *A Study-book for Everyday Problems in Science*. Chicago: Scott, Foresman and Company, 1940. 346 p. \$0.80.

The authors have written this study-book to help boys and girls of junior-high-school age to obtain a sound foundation of important science understandings and to form good working habits in scientific thinking. The book abounds in everyday problems of science. The experiments are simple and stimulating enough to accomplish the fine purpose for which the book is written.

To provide thinking experiences for pupils of varying ability, three different types of exercises or assignments have been developed. In order to form a habit of thinking and habits of working, the pupil is taught to select and organize facts for a purpose with himself as the center of interest. An appreciation of science and the scientist is brought about in the novel way of presenting the work of science and what the scientist explains and then showing the student what he needs to learn and how he can explain what is happening. The book concludes with that highly important problem of "How can science help us to keep from wasting nature's wealth?" There are twenty units each with its accompanying problems, but provision is made for further practice material.

—Greta Oppe.

TULEEN, LAWRENCE F., MUEHL, WILLARD L., PORTER, GEORGE S. *Test It Yourself*. Chicago: Scott, Foresman and Company, 1941. 290 p. \$0.96.

This is an unusual chemistry manual containing some 70 experiments with consumer application for high school and junior college students. The Table of Contents reveals such consumer problems as cosmetics, textiles, foods, cleansers, fuels, lubricants, antifreeze materials, protective coatings, inks, dyes, stains, etc.—some 14 units which the student is asked to study and prove for himself. He is asked not just to demonstrate the principles of chemistry but to apply them. Teachers of chemistry and home economics will welcome such a text not just



as a workbook to supplement laboratory work in chemistry and home economics but as a complete laboratory course where emphasis is placed on consumer problems. It can be used with any high school text. A Teachers Edi-

tion of 294 pages (\$1.08) is also available. Suggestions for teaching each unit, objectives, principles and skills, apparatus and materials needed, are listed.

—Greta Oppe.

### SCIENCE REFERENCE BOOKS

HARVEY, E. NEWTON. *Living Light*. Princeton, N. J.: Princeton University Press, 1940. 328 p. \$4.00.

The author, professor of biology at Princeton University, has been a keen student of the light emanating from living creatures for 30 years and has travelled far and wide in pursuit of this specialty. Chapter I gives a brief history of cilioluminescence. Chapter II deals with light producing organisms from bacteria to protozoa to the higher types. It cites the many investigators who have studied and described such plants and animals. Chapter III discusses the various types of luminescence, IV its chemistry, V its physiology, VI its physical nature. The bibliography covers 30 pages. There are 50 pages of illustrations.

The book is technical, intended for the specialist though the layman will read parts of it and look at the pictures with much interest.

—E.R.D.

NATIONAL GEOGRAPHIC SOCIETY. *The Book of Birds*. Volumes 1 and 2. Washington, D. C.: National Geographic Society, 1939. 740 p. \$5.00 per set.

*The Book of Birds*, edited by Gilbert Grosvenor and Alexander Wetmore, is an answer to the needs of those who are interested in the out-of-doors—naturalists, sportsmen, vacationists, students, teachers and the like. While it is encyclopedic in nature, it is written in such a way that the reader is not only interested but thrilled with the adventures and discoveries relating to birds.

The articles about birds and the 633 biographies are the result of life long interests and observations and of research by outstanding authorities, such as Alexander Wetmore, T. Gilbert Pearson, Arthur A. Allen, Robert Cushman Murphy, Frederick C. Lincoln, Francis H. Herick, Henry W. Henshaw, and many others whose names are well known to students of ornithology.

In this two volume set of 740 pages, there are 204 pages of full color plates, all of which are by Major Allan Brooks. Nine hundred and fifty birds are pictured. In addition, there are 232 monochrome photographs, many of which are by Arthur A. Allen. Seventeen maps show the results of study of migration of birds as it has been developed through bird banding.

"This new *Book of Birds* of the National Geographic Society is the first complete work ever published which portrays with comprehen-

sive detail and illustrations in full color all of the major species of birds of the United States and Canada."

This beautiful set of books is invaluable for old and young alike and should be in every public and school library. No private collection of out-of-door literature is complete without it.

—F.G.B.

NATIONAL GEOGRAPHIC SOCIETY. (Edited by John Oliver LaGorce). *The Book of Fishes*. Washington, D. C.: National Geographic Society, 1939. 367 p. \$3.50.

This is a revised and greatly enlarged book relating to food and game fishes and other inhabitants of inland and coastal waters of North America. This new volume contains 102 biographies of fresh and salt water fishes; 105 pages of full color; 162 photographs; and paintings from life of 131 species. This comprehensive book stands alone in its wealth of fascinating, non-technical, and accurate information for the student, sportsman, and lay reader. Contributors to this volume are authorities, such as John Oliver LaGorce, Charles Haskins Townsend, John T. Nichols, Louis L. Mowbray, Leonard P. Schulz, Roy Waldo Miner, Van Campen Heilner, Russell Maloney, and Imogene Powell. Every public and school library should own a copy of *The Book of Fishes*.

—F.G.B.

BEATY, JOHN Y. *Trees*. New York: M. A. Donohue and Company, 1938. 96 p. \$1.50.

The out-of-doors is full of stories which can be read easily by anyone who is interested. Wide awake boys and girls can read many of them if they observe carefully and interpret what they see. In the book, *Trees*, the author accompanies his two young nephews on a hike in the Dune section of Northern Indiana and helps them explain many familiar phenomena about trees. They observe the work of common enemies of trees, such as insects, weather, and disease. They note evidences of ways in which trees protect themselves from the ravages of their enemies. The first hand experiences of these three explorers become so real to the reader that, in spirit, he becomes a member of the party and with them develops a more sympathetic understanding of the life and struggle of trees that goes on almost unnoticed wherever trees are found.

The book is beautifully illustrated with sixty-six photographs many of which were taken by



the author. Some of the photographs are from the files of the United States Forest Service. This is an excellent book for the school and home library.

—F.G.B.

COMPTON, RAY, AND NETTELS, CHARLES H. (Editors). *Conquests of Science*. New York: Harcourt, Brace and Company, 1939. 378 p. \$1.20.

This book is a collection of twenty-two selections taken from the writings of famous men and women in various fields of science. The information in each selection is accurate since each author is a specialist in his field of interest. The authors give their readers interesting experiences, such as a visit to the peculiar yet fascinating birds that live on the Island of Penguins; a trip to see the Hoatzins in their tropical home in British Guiana; an opportunity to follow the remarkable life story of the salmon; a trip into Africa to see bats, the most peculiar of mammals; and an opportunity for interesting glimpses in the life work of Luther Burbank, Pierre and Marie Curie, Anthony Leeuwenhoek, and Maud Slye. Among the authors represented are such well-known names as Roy Chapman Andrews, William Beebe, Charles F. Brooks, Eve Curie, Raymond Ditmars, Raymond Jaffe, David Starr Jordan, Cherry Kearton, John Muir, and Paul B. Sears.

This book is concerned with various phases of science of interest to lay readers. The articles are not technical and they are beautifully illustrated by photographs. They are good science, and cover a wide range of interest. To some, the book may serve as an introduction to the world of science. To the junior and senior high school student, it will be fascinating reading about the efforts of men and women who have made it possible for them to know more about themselves and about the interesting world in which they live.

—F.G.B.

GANN, ERNEST K. *All American Aircraft*. New York: Thomas Y. Crowell Company, 1941. 122 p. \$2.00.

One of the most thrilling chapters of American history is the development of the airplane to its present position in the field of transportation. This book describes in detail over forty kinds of aircraft in production today. Horsepower, places, cruising range, engines, weight, and speeds are given for each plane.

The author, a young American Airlines pilot, has divided his new book into three sections, each describing types of modern planes. The first group includes commercial types, such as DC-3, the most widely used of all, the Boeing Stratoliner, the Boeing Clipper, and the Bellanca. The second section includes types of private aircraft, those which are used for business and pleasure. The last group includes the

military types which are so important in our defense program—the "Flying Fortress," capable of carrying bombs 1500 miles, dropping them, and then flying back without a stop; the P-39 Airacobra with a top speed of over 400 miles per hour; the Lockheed, called the fastest military airplane in the world.

Ninety-five excellent photographs show these planes on the ground and in flight. This book is full of information about America's airplanes of today. Anyone interested in aviation, from the elementary school boy to the pilot, will enjoy reading it.

—Roy V. Maneval.

HARPOLE, JAMES. *Behind the Surgeon's Mask*. New York: Frederick A. Stokes Company, 1940. 308 p. \$2.75.

This volume consists of a series of popular case histories by a famous British surgeon. Each tale is complete in itself. The reader may dip into the book here and there as he wishes. The language is non-technical so that the reading presents no difficulties for the layman.

The stories are intended to reassure laymen who are unfamiliar with surgical practices and hospitals. There is a human interest center in each case presented. In order to allay the possible fears of laymen the reviewer recommends taking the series in small dosages. It is not a book to be read at one sitting.

—R.K.W.

WILLIAMS, MAJOR AL. *Airpower*. New York: Coward-McCann, Inc., 1940. 433 p. \$3.50.

There is a brief historical introduction and then follow accounts of what the author saw and learned during his tours of Europe to inspect aviation there, to study Ealy's Abyssinian campaign, the development of air power in Germany, France, Russia, and England. The history of the air operations in Spain, of the German conquest of Poland, Norway, the Low Countries and France is given in considerable detail. Then the author applies his findings to the problems of American defense. He thinks that must be primarily aerial and that the United States is not justified in sacrificing its own defense to aid England. The facts he gives are vitally important and his analysis of the situation worth careful consideration.

—E.R.D.

CHALMERS, SIR PETER MITCHELL. *The Childhood of Animals*. New York: Penguin Books, Inc., 41 East 28th Street. 243 p. \$0.25.

This is one of a series of inexpensive reprints of classical works. *The Childhood of Animals*, first published in 1912, is based on lectures given as one of the series of well-known Christmas lectures given each year for young audiences at the Royal Institute, and to which the leading scientists of England contribute. The author combines interesting and specific description of

species with a broad and fundamental interpretation of biological principles. The teacher of biology will find it a rich source of specific illustrative material. The teacher will be interested in the last two chapters dealing with the purpose of youth and the function of the period of childhood in education.

—O. E. Underhill.

ZNANIECKI, FLORIAN. *The Social Role of the Man of Knowledge*. New York: Columbia University Press, 1940. 212 p. \$2.50.

The author traces the rise of the investigator—the man whom society now supports as a valuable addition to its producers, the producer of knowledge. Earlier he was reviled, persecuted or merely ignored. It is a book well worth reading—an assertion best verified by an excerpt. "Explorative thinking . . . is actually a new type of scientific thinking . . . the very standardization of this new type of thinking is far from completed. There is no 'logic' of creative thought; there are no principles of the search for new knowledge . . . and we lack completely any educational method for preparing future explorers for their function." (Page 168, 169.)

—E.R.D.

MORGAN, ALFRED. *Things a Boy Can Do With Electrochemistry*. New York: D. Appleton-Century Company, 1940. 198 p. \$2.00.

More than forty experiments which boys can perform themselves are given in this new and fascinating book. It is especially valuable for the interesting way in which the author has given to his readers the story of the development of electrochemistry to its present place in modern industry. The author shows the importance of electrochemistry in the production of chlorine, copper, magnesium, aluminum, and other elements. Elementary electricity and the ionization theory are explained in simple terms, and are followed by explanations of electrochemical processes.

Diagrammatic illustrations are found throughout the book. The boy who is interested in chemistry or electricity will find this book fascinating and instructive.

—Roy V. Maneval.

RICHARDSON, E. G. *Physical Science in Art and Industry*. New York: The Macmillan Company, 1941. 293 p. \$3.50.

This book might have been better named *Physics in Art and Industry*. It is a non-mathematical account of what Physics has been doing in recent years for art and industry. It treats of physics as applied in the locomotion of vehicles, ships and aeroplanes, communication, pottery, the culinary arts, and the fine arts and archaeology, on the farm, down the mine, and to river hydrology, building materials, architecture,

music, textiles, and the art of war. Dr. Richardson is a lecturer in physics in King's College, University of Durham, and has carried out research in several of these fields. One or more of his papers are included in the reference of thirteen of the chapters. This practical experience of the author enhances the value of the book which has been written for research workers, teachers, and students.

—H. A. Miley.

HOOGSTRAAL, HARRY. *Insects and Their Stories*. New York: Thomas Y. Crowell Company, 1941. 144 p. \$2.00.

If you wish to create an interest in insects in anyone, ask him to read this book. It is beautifully illustrated with photographs and drawings by Melvin Martinson. The descriptions are brief but give the life history and interesting behavior of each insect. A full page photograph and numerous smaller cuts accompany each story.

—W.G.W.

SANDERSON, IVAN T. *Living Treasure*. New York: The Viking Press, 1941. 290 p. \$3.50.

This is an account of the author's collecting excursion chiefly in Jamaica, British Honduras, and Yucatan. Many exciting incidents in the tropical forests and jungles do not allow our interest to relax. Uncommon types of common animals broaden our views of animal life. The book is illustrated with 32 full page beautifully executed drawings by the author. It is a book for lovers of animal life to read and enjoy.

—W.G.W.

FRASER, CHELSEA. *Famous American Flyers*. New York: Thomas Y. Crowell Company, 1941. 352 p. \$2.50.

Are you interested in obtaining biographies of flyers who have made American aviation history? This book will give you in an interesting manner the details of the flyers' lives. The biographies are arranged chronologically, discussing in turn the Wright Brothers, Glenn H. Curtiss, Edward V. Rickenbacker, Albert C. Read, John Rodgers, Richard E. Byrd, Charles A. Lindbergh, Amelia Earhart Putnam, Frank M. Hawks, Wiley Post, Edwin C. Musick, Howard Hughes, and Douglas Corrigan. The book is illustrated with maps by the author and a few photographs.

Mr. Fraser brings out the personalities of his heroes by relating incidents which are not found in ordinary biographies. Each story brings the flyer to his place in American aviation today. This book would be a valuable addition to any home or school library. Anyone, whether interested in aviation or not, will enjoy reading this splendid collection of biographies of America's foremost airplane pilots.

—Roy V. Maneval.

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